Urban areas at the front-line of a fundamental transition:

Exploring the stimulating factors for low-carbon urban development in the European Union

Roger Toussaint
Utrecht University
3542564
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R.R (Roger) Toussaint
Bc. Regional Development & Innovation
R.R.Toussaint@students.uu.nl

Prof. Dr. P.P.J. (Peter) Driessen
Utrecht University

Drs. P.R. (Peter) Bosch
TNO Utrecht

SUMMARY

Carbon dioxide (CO_2) is the most important anthropogenic greenhouse gas (GHG) and warming of the global climatic system is now unequivocal and evident from observations in the environment (IPCC, 2007b). Limiting global average temperatures to 2°C above pre-industrial levels is necessary to avoid unacceptable negative impacts. A major transformation towards a low-carbon economy and society is called for which requires the developed countries to radically reduce emissions during the next forty years (*ibid.*).

Urban areas play an important role in the reduction potential as they "consume the bulk of the world's energy and [are] thus perhaps the single largest 'source' of global CO_2 emissions" (Corfee-Morlot, et al., 2009, p. 17). Cities and urban areas around the world are growing at an extraordinary rate and subsequently will contain 60% of the world's population by 2030 (UN-Habitat, 2011).

In response to climate change, the debate around GHGs and the need for more sustainable urban development, the concept of *'low-carbon development*' (LCD) was developed. As most of the buildings that are expected to make up the EU building stock in the required low-carbon future already exist today, and energy performance and other environmental standards have gradually been tightened since the 1970s, much of the carbon reduction potential in cities may be realized by encouraging urban *redevelopment* at the neighbourhood level and the incorporation of LCD strategies (Newton, 2010).

However, regardless of some ambitious policy objectives, there remains a significant gap "between the rhetoric of reducing GHG emissions at the urban level and the realities of putting such policies and schemes into practice (...)" (UN-Habitat, 2011, p. 115). National governments are not able to meet their international commitments for addressing mitigation without localised action and support (UN-Habitat, 2011). The fundamental challenge is to provide the enabling conditions for the transition to low-carbon futures which has to engage both with socio-economic, politico-institutional and technical structures and practices.

The research therefore aimed to identify and explain successful low-carbon urban redevelopment strategies at the neighbourhood level in front-running European urban areas to improve the future design of sustainable urban development policies. Although the research found several stimulating factors in four case-studies and an extensive literature research, there is no ready-made approach to delivering low-carbon residential areas. The research provided an overview 'ingredients' on which future low-carbon developments could build. However, because climate change will have different effects at different localities, low-carbon development should aim to integrate local policy aims and development issues. Moreover, the research has shown that low-carbon urban development should be best implemented through an *inclusive, cooperative and integrated approach* to planning and will benefit from *ambitious, visionary and proactive stakeholders* who are at the basis of the stimulus for the low-carbon component in contemporary urban development.

Key concepts: Low-Carbon Urban Development, Sustainable Development, Governance, Stimulating Factors

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1 INTRODUCTION & RESEARCH OBJECTIVES

1.1 PROBLEM DESCRIPTION

In recent years, the threats of climate change, resource depletion and energy security have become increasingly clear. In 2007, the Intergovernmental Panel on Climate Change (IPCC) concluded that carbon dioxide (CO_2) is the most important anthropogenic greenhouse gas (GHG) and that warming of the global climatic system is now unequivocal and evident from observations in the environment (IPCC, 2007b). Limiting the global average temperature to 2°C above pre-industrial levels is necessary to avoid unacceptable negative impacts. A major transformation towards a low-carbon economy and society is called for which requires the developed countries to radically reduce emissions during the next forty years (ibid).

The impact of urban areas & the need for change in contemporary urban development

These developments have led to a need to re-think the way in which we build and re-develop our urban areas (Williams, 2012). Urban areas play an important role in the reduction-potential as they "consume the bulk of the world's energy and [are] thus perhaps the single largest 'source' of global CO_2 emissions" (Corfee-Morlot, et al., 2009, p. 17). The International Energy Agency (IEA) estimates that 60-80% of world energy use emanates from cities and towns[1] (IEA, 2008). Moreover, urban areas around the world are growing at an extraordinary rate and subsequently will contain 60% of the world's population by 2030 (UN-Habitat, 2011).

Most scholars agree that the contemporary way of urban development threatens both the urban as well as our natural environment and is generally seen as an unsustainable form of development (Garde, 2004). The development of "responses to climate change that recognize the synergies between climate change and sustainable urban development" has become a common goal and research topic (Romero-Lankao & Dodman, 2011, p. 117). Policy responses typically focus on *adaptation* or *mitigation*[2] but can be complementary, substitutable or independent of each other. However, the IPCC (2007c) concluded that mitigation investments in the long run have a greater potential in avoiding catastrophic climate change damage than does adaptation and that this potential is greater than the adaptation options currently being adopted. Moreover, much of the carbon reduction potential in cities may be realized by encouraging urban *redevelopment* as it contributes to reducing urban sprawl through the reduction of migration of urban populations to suburban communities (Newton, 2010). Unlike '*greenfield'* urban development which constitutes low-density urban growth on previously undeveloped land[3], redevelopment refers to a more general notion of urban development on previous developed land (*ibid.*). In this research, redevelopment refers to grey- and/or brownfield urban development. 'G*reyfield*' development constitutes the redevelopment of occupied but economically, technologically, environmentally or socially obsolescent or disadvantaged urban structures whereas *'brownfield'* development constitutes the redevelopment and retrofitting of those parts of the city which have 'outlived' their original industrial-era functions[4] and require some form of site remediation (*ibid.*). As most of the buildings that are expected to make up the EU building stock in the required low-carbon future already exist today, and energy performance and other environmental standards have gradually been tightened since the 1970s, the key to achieving a low-carbon urban development is to redevelop and improve the existing urban environment (*ibid.*).

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[1] By 2030, the urban energy consumption will have risen to 75% within the European Union (EU) alone (IEA, 2008).

[2] Mitigation consists of measures, such as the promotion of renewable energies, to reduce the rate and amount of GHG-emissions into the atmosphere to manageable sustainable levels whereas adaptation consists of measures to cope with the effects of climate change, such as rising sea levels.

[3] Unused land typically can be rural, agricultural or unused land on the outskirts of urban areas.

[4] Former land use activities can include; oil installations, power plants, scrap yards, factories etc.

Levels of urban development

Redevelopment can be done on three distinct spatial levels, namely the *macro* (the regional, city, or town), the *meso* (the district or neighbourhood) and *micro* level (the street or building). Newton (2010) argues that any transition towards sustainable urban development, needs to take into account the scarcity of land, increasing environmental protection, housing affordability and increasing land value and should therefore take redevelopment at a neighbourhood level as its principle vehicle for urban transformation of cities.

The neighbourhood level is preferred as it is generally agreed that better-designed redevelopments appear to be associated with more consolidated redevelopments, not individual and fragmented projects (ibid). In earlier research, the integration of sustainability principles into neighbourhood design had already been identified as essential because many of the problems encountered at the macro city scale are indeed cumulative consequences of poor planning at the neighbourhood level (Engel-Yan, et al., 2005). "Neighbourhood-scale analysis is necessary to evaluate and develop more efficient and sustainable local urban infrastructure (…)" (ibid: p. 45). Much of the focus in sustainable urban design and planning has therefore shifted from the city scale to the neighbourhood scale, which are eventually the backbones of cities (*ibid.*). Moreover, considering the governance literature and the importance of participatory processes in sustainable development, broad participation is likely to be most practical at the local or neighbourhood level (UN-Habitat, 2011).

Introducing the concept of low-carbon urban development

In response to climate change, the debate around GHGs and the need for more sustainable urban development, the concept of *'low-carbon development'* (LCD) was developed. The term LCD conceptualises strategies in which urban development, adaptation and mitigation efforts are reconciled (Figure 1).

However, mitigation policy currently dominates LCD policies with adaptation given a limited focus (Mulugetta & Urban, 2010). An integration of both responses can be found "as part of the need to introduce climate resilient principles and practices into LCD" (*ibid.*, p. 7546).

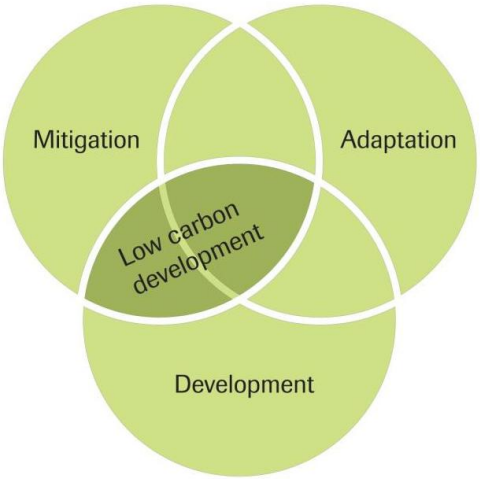


Figure 1: Low carbon development (ECN, 2011)

Currently, there is no internationally agreed definition of LCD, yet the concept of 'using less carbon for growth' is commonly implied by LCD (*ibid*.). Low-carbon development strategies and policy measures tend to focus on '*low carbon growth*' and/or '*low-carbon lifestyles*'. The first has a focus on the production or provision of low-carbon goods and services with the aim of decoupling economic growth and CO_2 emissions. Responses are then aimed at technological innovation and sectorial change. Strategies and measures aimed at low-carbon lifestyles tend to focus on consumer's ability to mitigate carbon emissions through the consumption of climate friendly products or other measures assuming "that the consumer would be in the position to achieve these cuts through lifestyle and behavioural adjustments, but successful outcomes are also predicated on how well the supportive policies are in place to deliver better public

services and market conditions for 'green' products" (ibid; p. 7548). In this research low-carbon urban development is therefore conceptualised as:

> *A development that aims to reduce the emission of carbon dioxide in urban areas, trough policy and/or technological measures designed to change contemporary urban growth and/or urban lifestyles.*

The challenges of urban planning for LCD

Urban planning has a considerable effect on emission levels of urban areas and ultimately there "is no alternative for countries but to incorporate low-carbon measures in their development policies" (ibid; p. 7548). "How cities develop matters to the delivery of a low-carbon, climate resilient future, and it will also determine the feasibility of sustainable economic development across the OECD and worldwide" (Corfee-Morlot, et al., 2009, p. 8). This places LCD at the centre of urban planning and the climate change mitigation agenda.

However, although the necessary technical changes for LCD might be accomplished, the ambition to stabilise CO_2 emissions at a level preventing dangerous interference, entails a unique policy challenge as "(...) any process of social change is dependent on and restricted by different institutional contexts" (Söderholm, et al., 2011, p. 1106). Additionally, the transformation to a low-carbon society has to take place in a short period of time[5], is contingent on path-dependencies and lock-ins to certain technologies and is "(...) likely to require new approaches to governance (...)" (*ibid.*, p. 1106). As it is "unlikely [...] that public policy of any significance could result from the choice process of any single unified actor" (Scharpf, *1978,* p. 347), governance employs a more participatory form of governing in order to generate a greater understanding of the problem, a better understanding of conflicting values and beliefs and to create social support for policy measures (Pierre, 2000; Driessen, et al., 2001). Correspondingly, national governments are not able to meet their international commitments for addressing mitigation without localised action and support (UN-Habitat, 2011). In this research the focus is on *environmental governance* which is defined as "interventions aiming at changes in environment-related incentives, knowledge, institutions, decision making, and behaviours" to prevent, reduce and/or mitigate harmful effects on the environment (Lemos & Agrawal, 2006, p. 298).

Cities responding to climate change & the reduction of urban carbon emissions

Increasingly aware of the combined effects of urbanization and climate change and its effect on environmental, economic and social stability, some city authorities are actively involved in reducing CO_2 emissions. Countries such as the United Kingdom (UK), Germany and Sweden are seen as key promoters of climate policies aimed at mitigation (UN-Habitat, 2011). Several European cities[6] have started as pioneers of change and provide others with elements of best practice for urban mitigation (Simonis, 2011). Moreover, the Covenant of Mayors Initiative of the European Commission formally commits about 800 European cities to reduce their CO_2-emissions by 20% by the year 2020. These examples of pioneers in climate change mitigation can be conceptualised as '*urban living labs*'; a geographical identification of an urban area with a high ambition to transition to a low-carbon environment where opportunities are created to experiment with new technologies and concepts.

Taken together, the above indications and developments require that any strategy aimed at governing the transition to low-carbon futures, has to engage both with socio-economic, politico-institutional and technical structures and practices. The fundamental challenge is to provide the enabling conditions for "system transformations and to stimulate, coordinate and steer the transitions in certain, desired directions while taking into account various interests and perspectives" (Söderholm, et al., 2011, p. 1107). Increasingly, low-carbon approaches to infrastructure, lifestyles

[5] The IPCC (2007a) predicts as early as 2020 to prevent dangerous interference with the climate system.

[6] Barcelona is drastically increasing its renewable energies use, Swedish cities are focused on biomass power and London is setting ambitious GHG-reduction targets. Moreover, Stockholm, Hamburg, Vitoria-Gasteiz and Nantes were awarded the European Green Capital title and Jühnde and Furth in Germany have switched entirely to renewable energies, becoming "places of pilgrimage to all sorts of planners from around the world" (Simonis, 2011, p. 929).

and buildings are encouraged in urban areas. Cities across the world have started to develop low-carbon neighbourhoods and "some of the most cited examples can be found in Europe" (Williams, 2012, p. 132).

Implementation deficit

However, regardless of some ambitious policy objectives, the reality of reducing GHG-emissions is often more challenging than anticipated, leaving climate change mitigation a marginal issue in most cities (UN-Habitat, 2011). Best practices, can be identified but there remains a significant gap "between the rhetoric of reducing GHG emissions at the urban level and the realities of putting such policies and schemes into practice (...)" (ibid, p. 115). Action at the local level is constrained by lack of expertise, institutional capacity, abilities to develop and enforce policies, informal settlements and because policy-making for climate change mitigation remains "largely confined to the environmental domains of municipal governments (…)" (ibid; p. 123).

In an earlier report, "the need for an evidence base to enhance the ability to identify and diffuse best practices, not only at local scale but also in terms of how national and local government partners can work better together", was identified (Corfee-Morlot, et al., 2009, p. 88). There is, moreover, little evidence of climate change mitigation being approached in a strategic or comprehensive manner, with "(…) relatively few examples of inclusive and participatory approaches to urban climate change mitigation governance" (UN-Habitat, 2011, p. 123). According to Khakee, et al., (2008, p. 83), "the implementation of (…) [sustainable development] is not simply a task for one single profession, but instead to be handled jointly in cooperation with practitioners and stakeholders representing different sectors, competencies, interests and cultures. Preparatory work and decision-making are not simply instrumentally rational processes guided solely by explicit 'facts', goals and means."

It is thus hypothesized that successful low-carbon redevelopment strategies at the neighbourhood level, depend on a number of stimulating factors. Hence, to make low-carbon projects more instrumental and successful in the development towards sustainable urban futures, insight into the stimulating factors of successful low-carbon redevelopment needs to be obtained. Analysing the variety of strategies and measures in low-carbon redevelopment projects in different urban areas, may possibly be very insightful into matching low-carbon urban redevelopment against a range of stimulating factors. An evidence base on successful approaches to low-carbon redevelopment and its stimulating factors could inform sound urban policy development and the implementation of low-carbon measures.

EURBANLAB-initiative

Responding to the above described challenges and initiatives, the Climate Knowledge and Innovation Community (Climate-KIC) aims to be at the forefront of this 'green revolution', providing the innovations, entrepreneurship, education and expert guidance needed to shape Europe's climate change agenda (Climate-KIC, 2012). According to Climate-KIC, urban living labs play an important role in the climate change innovation process in the urban environment. These urban areas with a high ambition to transition to a low-carbon resilient city form the playground for innovative climate change policies and technologies. In order to enhance the effectiveness of existing urban living labs for systemic innovations and to facilitate the transition towards low-carbon resilient cities, the Climate-KIC aims to bring the unconnected experiments and partners together in one European network called "EURBANLAB".

As a leading partner in the EURBANLAB initiative, TNO Utrecht is interested to learn what other leading European cities are currently undertaking with respect to LCD and which factors stimulate successful low-carbon projects at the local level.

The above problem description is conceptualised in the following problem definition:

> *It is unclear **what** the level of ambition is, **how** low-carbon measures are implemented, **which** results are reached and what factors might **explain** successful low-carbon strategies at the neighbourhood level in front-running European urban areas.*

1.2 RESEARCH OBJECTIVE

An analysis of the variety of successful low-carbon redevelopment projects implemented in different urban areas and geographical contexts would provide us with a useful insight into the key factors stimulating the success of low-carbon redevelopment strategies. By doing so, the research aims to contribute to the knowledge which is required to close the gap between the rhetoric of reducing CO_2 emissions at the urban level and the realities of putting such policies and schemes into practice. Moreover, the research aims to analyse whether interactive governance approaches are constitutive for LCD strategies. It is hypothesized that the implementation of low-carbon measures, together with sound policy interventions trough interactive governance structures, are necessary to support successful LCD projects in urban areas.

The main objective is to:

> *Contribute to the knowledge required to closing the gap between the rhetoric of reducing GHG-emissions at the neighbourhood level, and the realities of putting such practices into practice.*

This research aims to contribute to the knowledge required to closing the gap between the rhetoric of reducing GHG emissions at the urban level and the realities of putting such policies and schemes into practice, as identified by the United Nations (UN-Habitat, 2011).
The research aims to provide:

- Descriptive knowledge by giving an overview of current practices and governance arrangements in successful low-carbon redevelopment strategies for the development of a more sustainable urban environment;
- Explanatory knowledge by evaluating the relative importance of stimulating factors in low-carbon redevelopment for a better understanding of successful low-carbon projects;
- And prescriptive knowledge by providing urban planners and policy-makers with an overview of stimulating factors which might improve future design of strategies for a more sustainable urban environment.

1.3 RESEARCH QUESTIONS

The following section describes the full research question and corresponding sub-questions.

Central research question:

> *Which stimulating factors can be identified at the neighbourhood level, that might explain the success of low-carbon urban redevelopment strategies in front-running European areas, and could improve future initiatives of low-carbon urban redevelopment?*

Sub-questions:

1. What is level of ambition of governments and, at the local level, the project ambition?
2. What measures and instruments can be identified in the low-carbon development approaches?
3. What results were achieved?
4. How was the developing process organised and executed?
5. What is the applied mode of governance?

1.4 RELEVANCE & DELIMITATIONS

Societal relevance

Climate changes interact with urbanization and, consequently, increases the challenges faced by urban governments in relation to the development of urban areas and connected environmental issues (Corfee-Morlot, et al., 2009). Climate change is expected to have several direct impacts across many sectors of city-life, many of which are expected to intensify existing vulnerabilities and social issues in the future (IPCC, 2007b). Some risks identified are the 'urban heath island effect', directly affecting human health, and changes in the frequency and severity of storms, precipitation, droughts and other weather extremes of relevance for urban centres (ibid). Mitigating climate change therefore should be an important characteristic of urban development for liveable urban environments. However, as mentioned before, the reality of implementing such a development is more challenging than anticipated and climate change mitigation remains a marginal issue in most cities (UN-Habitat, 2011).

The central question of LCD to lower CO_2 emissions revolves around the scope of LCD initiatives to effectively direct the transition towards a low-carbon society. This research aims to provide further insight into the stimulating factors for successful low-carbon development strategies. Low-carbon policies might be made more effective if we better understand these underlying factors or mechanisms. Ultimately, such insight is to bridge the gap between the rhetoric of reducing CO_2 emissions and daily practice, in due course contributing to more sustainable and liveable urban areas.

Scientific relevance

This research aims to contribute to the knowledge required to closing the gap between the rhetoric of reducing GHG emissions at the urban level and the realities of putting such policies and schemes into practice, as identified by the United Nations (UN-Habitat, 2011). By doing so, the research aims contribute to the needed evidence base of best practices and the diffusion of best practices, as identified by Corfee-Merlot et al., (2009), by generating an overview of key factors shaping the success of LCD strategies.

The research connects to the theoretical debate on the requirement of governance approaches in sustainable development initiatives such as LCD. As Scharpf (1978; p. 347) identified, any intervention in the public realm is forced to operate in a growing "complex network of public and private actors, connected by diverse relationships and dependencies" rendering it "unlikely [...] that public policy of any significance could result from the choice process of any single unified actor". A different style of governing, coined in scientific literature as 'governance', employs a more participatory form of governing to create social support for policy measures (Pierre, 2000; Driessen, et al., 2001). The United Nations' report concluded, however, that there are currently "(…) relatively few examples of inclusive and participatory approaches to urban climate change mitigation governance" (UN-Habitat, 2011, p. 123). This report therefore includes the analysis of different governance approaches in successful LCD strategies in an attempt to identify the need for governance in successful LCD.

Delimitations

The research has a number of delimitations related to the available resources and the chosen strategy. Concerning the scope of the research, a first delimitation is related to the focus on low-carbon urban development in front-running European cities. The geographical limitation is apparent, yet the focus on low-carbon development entails that the only GHG covered in this research is CO_2. Specific measures aimed at reducing other GHG's are therefore not included in the research. Moreover, the focus is on mitigation, and adaptation measures are included if they have a mitigation component.

The cases are furthermore selected on the basis of completion. The research aimed to analyse projects which are in the process of implementation or have been implemented. An important point to make is that in this research the interest goes towards analysing the conditions for the process of developing and implementing effective low-carbon development strategies. The aim is thus not to say anything about the desirability of implementing different types of low-carbon technologies or specific policies for the reduction of CO_2. Possibly the desirability of technologies and policies by actors in the field might well play a role in the analysis and might influence the implementation of low-carbon strategies.

The complexity of any analysis increases with the scale of the study, especially in exploratory research and when seeking to maintaining an appropriate level of detail. The neighbourhood level of analysis, as compared to city-wide or the regional level, has been chosen as an intermediate between a too constricted level and an exceedingly complex level, considering the available time and resources. A larger scale of analysis may raise problems in collecting and processing data and affects the intended in-depth analysis of successful LCD strategies. Conversely, the neighbourhood level of analysis allows for the analysis of interaction between the local authority and other stakeholders, and the analysis of experimentation and action in urban areas with a range of different local climate response policies, while permitting an in-depth analysis of stimulating factors and a cautious generalisation of the results. Additionally, the neighbourhood level has been identified as an appropriate level of urban development (Engel-Yan, et al., 2005).

In terms of data collection and processing, this study is limited to interviewing stakeholders that were involved in the case studies. Whilst it is acknowledged that there is a possibly that there will be other important stakeholders, this research focuses on a limited number of key stakeholders in order to collect important information in a limited interview period and with a limited amount of available resources. The willingness of key interviewees to participate and share their experiences and perceptions without holding back important information will be of influence on the reliability of the research findings. The research aimed to deal with this by asking key interviewees on forehand if they are willing to participate and ensure that stakeholders are anonymously cited. Moreover, the interviews are correlated with the available scientific literatures. The available literature and interviews are restricted to the Dutch or English languages because of a lack of resources for extensive translation.

The absence of statistical generalizations, as is the distinctive feature of the case study method, in this research entails that the research relies mostly on qualitative analysis- rather than quantitative statistical generalisations. Relatedly, the methodical restriction to best cases of LCD means that limiting factors or processes are systematically disregarded. Furthermore, because the nature of the research is exploratory rather than theory testing, no attempt was made to select cases based on hypothesized controlling variables.

Lastly, the external validity, the extent to which the study's findings can be generalised beyond the case studies, is in research with fewer cases often under pressure. Although this is of less importance in practice-oriented research projects, the limited case study approach "makes it more difficult (...) to declare the results applicable to (...) similar cases" (Verschuren & Doorewaard, 2005, p. 170). Incorporated four case studies in this research aimed at ameliorating the problem of a limited case study approach. If the results of this research are used in further research to analyse a range of different projects in a number of different countries, the external validity might be proven if the same results are found. The enhancement of the external validity in this research is sought after by using in-depth interviews with experts in the different cases. Moreover, a parallel research being conducted at TNO compares sustainable urban initiatives in Europe as well. Incorporating a larger sample of case-studies, the preliminary findings of this research have validated the results of this research, adding to the external validity of the stimulating factors found in this research.

2 RESEARCH DESIGN & METHOD

2.1 ANALYTICAL FRAMEWORK

The following paragraphs describe the analytical framework for the analysis of current successful low-carbon development projects in the EU. The analytical framework aims to combine elements of the literature on sustainable development, project management, and environmental governance. The approach includes elements of *historical analysis* with a *multi-level perspective* on *governance arrangements*. The analytical framework formed the basis for desk-research and field-research in four case studies in front-running European cities. By doing so, the analytical framework provides an overview of stimulating factors for low-carbon urban development.

There are two main phases in the research to examine the possible stimulating factors for low-carbon urban development:

1) Characterising the practice in place
2) Analysing the development process and governance approach

2.1.1 PHASE 1: CHARACTERISATION OF THE PRACTICE IN PLACE

Before the analysis of stimulating processes or factors can begin, the key elements of the existing practice first need to be described. Phase 1 aims to provide an overview of cases for sub-questions one, two and three. This first phase provides an overview of the LCD strategy by characterizing the "*field of activity*", "*government & project ambition*", "*applied technologies*" (i.e. CHP-power plant, hybrid vehicles) and the "*results & problems in use*".

2.1.1.1 THE FIELD OF ACTIVITY

There are roughly five fields of activity in spatial planning in which LCD strategies can be incorporated (Figure 2, adapted from Corfee-Morlot, et al., 2009). This type of characterisation allows for the identification of the *field of activity* (or a combination of fields) in which LCD projects aim to lower CO_2 emissions.
First, new approaches to energy policy have become prominent in local mitigation efforts which aim to improve energy efficiency or promote renewable energy solutions. Second, in the transport sector efforts to promote alternative forms of transportation and improving public transportation systems can be identified. Third, waste & water management primarily concentrate on mitigation trough prevention, reuse and recycling. Finally, urban land use & spatial structure (buildings and infrastructure) can range from new standards for buildings to strategic planning of new neighbourhoods.

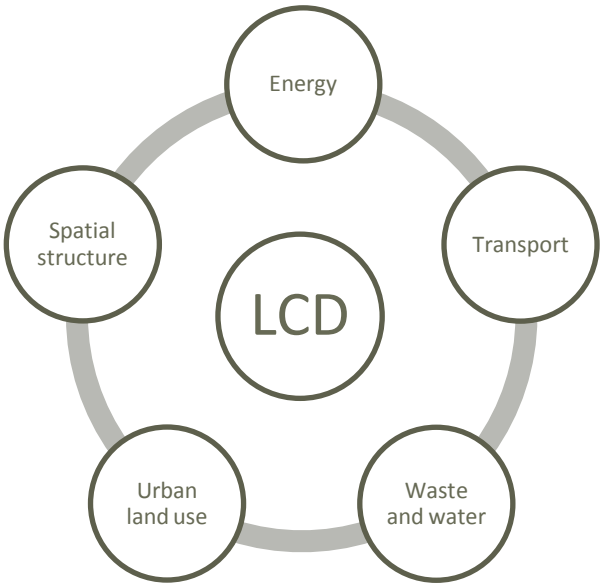


Figure 2: Field of activity

2.1.1.2 GOVERNMENT AND PROJECT AMBITION

Following the multilevel perspective, a first explanation is sought at a higher levels of government, namely the *national level*. While the ultimate solution to climate change is a global zero carbon economy, it is important that government initiatives, governance arrangements and economic incentives support, rather than undermine, efforts towards such a society. All European countries are subject to the same directives of the EU, but are expected to have different interpretations of the directives and therefore different ways of addressing CO_2 emissions. National policies, incentives and regulations are expected to shape the possibilities for low-carbon urban developments at the local level. The European Union has set a goal of limiting the temperature increase to no more than 20°C by 2050 (Rijksoverheid, 2012b). Targets are set for the Member States to reduce greenhouse gas emissions in 2020 by reducing energy consumption and by using a higher proportion of renewable energy. The EU targets for 2020 are:

- 20% reduction in EU greenhouse gas emissions below 1990 levels;
- 20% of EU energy consumption from renewable resources;
- 20% reduction in primary energy use compared with projected levels to be achieved by improving energy efficiency.

In relation to the vision on sustainable development in urban planning, i.e. it would be interesting to consider whether governments are signatories to international treaties, committing themselves to certain development paths and requirements. The treaties considered and their description are shown in Table 1.

Table 1: Overview of (international) treaties

Treaty	Description	Entered into force in
Covenant of Mayors	Bye signing the European Covenant of Mayors[7], local and regional authorities voluntarily commit themselves to increasing energy efficiency and the use of renewable energy sources. By their commitment, they support the European Union 20% CO_2 reduction objective to be reached by 2020.	2008
United Nations Framework Convention on Climate Change (UNFCC)	The UNFCC[8] is an international environmental treaty produced at the United Nations Conference on Environment and Development (UNCED, or Earth Summit. The objective of the treaty is to stabilize GHG-concentrations at a level that would prevent dangerous interference with the climate system.	1992
Kyoto Protocol	As part of the UNFCCC the protocol[9] commits signatories to reduce their emissions of four GHG's and two groups of gases.	2005
Agenda 21	Agenda 21 is a binding voluntary implemented action plan of the United Nations with respect to sustainable development. Agenda 21 provides options for combating degradation of the land, air and water, conserving forests and biodiversity. It deals with poverty and excessive consumption, health and education, cities and farmers. Agenda 21 calls on governments to adopt national strategies for	

[7] http://www.eumayors.eu/about/covenant-of-mayors_en.html

[8] http://unfccc.int

[9] http://unfccc.int/kyoto_protocol/items/2830.php

	sustainable development. These should be developed with wide participation, including non-government organizations and the public.	
Aalborg Charter[10]	The Aalborg Charter provides a framework for the delivery of local sustainable development, and calls for authorities to engage in Local Agenda 21 processes. The Charter was created as a response to the Earth Summit in Rio in 1992 and Brundtland's call to "think globally & trade locally", where the responsibilities of cities and local authorities regarding sustainable development were defined.	1994
Aalborg Commitments	The Aalborg Commitments are a set of shared commitments to be jointly implemented by local governments across Europe. The Aalborg Commitments document has two parts: the general commitment to be signed, and the commitments annex on suggested targets as inspiration for the target setting process. By joining the Aalborg Commitments the local government agrees to: • Within one year to develop a Baseline Review Report, describing the municipality's past efforts within the sustainability field and challenges that lies ahead. • Within two years to establish goals and action plans in cooperation with local citizens and other stakeholders, for the continued efforts for sustainable development. • Continuously publish Aalborg Commitments reports dealing with established goals and achievements.	2004
ICLEI –Local Governments for Sustainability	ICLEI[11] is an international association of local governments as well as national and regional local government organizations who have made a commitment to sustainable development.	

Secondly and more closely, the factors and processes at the *local level* are analysed. The local level is important as the transition to a low-carbon urban environment depends on local level decision-making and is best fitted to implement adaptive activities such as green roofs and energy reduction (Corfee-Morlot, et al., 2009). A first point of analysing the low-carbon ambitions at the local level is to examine the definition of emission reduction goals, which is expected to be very different between local authorities. Secondly, the targets in relation to the national target will be analysed. Some cities have adopted the Kyoto target to compensate for the inaction of their governments because they are unlikely to achieve their Kyoto commitment. Thirdly, the involvement in (transnational) networks such as the International Council for Local Environment Initiatives' (ICLEI) or the UNEP Climate Neutral Network is analysed. Finally, an overview of the project specific ambitions is provided.

[10] http://www.aalborgkommune.dk/english-version/sider/sustainable_development.aspx

[11] http://www.iclei.org/

2.1.1.3 APPLIED TECHNOLOGIES

The "*applied technologies*" is aimed at analysing the specific low-carbon measures taken in the low-carbon development project to realise the ambitions. The aim is to describe the different technologies applies as to provide an overview of technologies in current best practice cases.

2.1.1.4 RESULTS & PROBLEMS IN USE

Lastly, the case studies will be analysed according to their results. An overview will be provided of achieved results and problems in use. It is expected that some of the measures taken, or technologies implemented, can result in problems during the use phase of a project. Especially for innovative and experimental technologies.

2.1.2 PHASE 2: DEVELOPMENT PROCESS AND GOVERNANCE ANALYSIS

In the second phase of the analysis, the focus will turn to the identification of stimulating factors and/or procedures, which have influenced the development process and implementation of LCD strategies in front-running cities, by analysing the '*development process'* and by determining the '*governance approach'*. Phase 2 aims to find stimulating factors in different case-studies and answer sub questions 4 and 5.

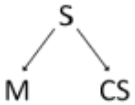
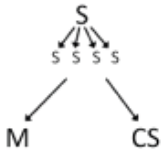
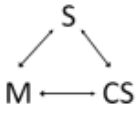
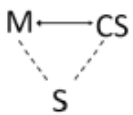
2.1.2.1 DEVELOPMENT PROCESS

As the research aims to find stimulating factors for the development of low-carbon urban redevelopment projects, the focus is on project success factors which can be identified to have been necessary in order to achieve project success. In order to guide the analysis of the different case studies and to identify the stimulating factors which have contributed to the success of the project, the development process will be analysed using the analytical framework below. The framework was developed by combining the scientific input from different literatures (Kasioumi, 2011; ECN, 2011; and Fortune & White, 2006 in: Abdalla, 2012).

Case studies were analysed along the seven main themes shown on the left side of the table. These themes are operationalised on the right side of the table and serve as a guidance in the analyis of the case studies. The last theme "Governance analysis: role of the governement" is added to the model based on the conceptual framework developed by Driessen et al., (2012), see Table 3. Local governments can use different methods of governance to foster low-carbon urban development. The "*applied mode of governance*" is aimed at analysing the specific instruments, rules and processes that lead to decisions and measures to realise the stated ambitions. The main building blocks for the different types of governance arrangements are the *actor base*, *institutional features* and *policy content*. Differences in these building blocks allows for a differentiation of five ideal types of environmental governance arrangements. The operationalization of these building blocks for governance arrangements is included in Table 2 below. Although in practice these modes of governance will most likely overlap and individual measures most likely will be based on a mixture of several modes of governance, these distinctions create a framework which allows for the analysis of urban environmental governance and the measures preferred by local actors.

Table 2: Analytical framework for the developing process & identification of stimulating factors

Control of the planning process: main actors, roles & responsibilities	Authorship of the plan (public, private, single or multiple), main actors & responsibilities, resources devoted
Vision, goals & means	Presence of a comprehensive yet realistic vision, goals set forth from the beginning, measurable targets or limits set, degree of emphasis on procedure (goal-oriented versus process-oriented planning). Adequate budget, sufficient resources, proven/familiar technology.
Performance monitoring	Effective monitoring, feedback mechanisms
Transformations	Availability of skilled/sufficient/qualified labour, performance by contractors/suppliers/consultants
Participation & Communication	Degree and quality of stakeholder participation, quality and focus of communication and coordination among actors (consensus-building versus alliance-building planning).
Environment	Environmental influences, windows of opportunity, past experience
Continuity	User client involvement, project champion, effective change management, different viewpoints (appreciating), political stability, overcoming uncertainty/risk management
Governance analysis: role of the government	Degree of local government control over implementation (proactive versus reactive planning, initiating actors, stakeholder position, policy level, power base, model of representation, rules of interaction, mechanisms of social interaction, goals & targets, instruments, policy integration, policy-science interface.

		Centralized governance	Decentralized governance	Public - private governance	Interactive governance	Self-governance
						
Actor features	**Initiating actors**	Central gov't agencies (or supra national bodies)	Gov't at its various levels of aggregation (subsidiarity)	Central gov't agencies; private sector is granted a preconditioned role also	Multiple actors: gov't, private sector and civil society	Private sector and/or civil society
	Stakeholder position	Stakeholder autonomy determined by principal agency	High likelihood of stakeholder involvement	Autonomy of market stakeholders within predetermined boundaries	Equal roles for all network partners	Self governing entities determine the involvement of other stakeholders
	Policy level	(Supra) national state	Lower levels of gov't	Local to international level	Multiple levels	Local to international level
	Power base	Coercion; Authority; Legitimacy (democratic representation at the national level)	Coercion; Authority; Legitimacy (democratic representation at lower levels)	Competitiveness (prices); Contracts and legal recourse; Legitimacy (agreement on relations and procedures)	Legitimacy (agreement on roles, positions, procedures and process); Trust; Knowledge	Autonomy; Leadership; Group size; Social capital; Legitimacy (agreement on relations and procedures)
Institu-tional features	**Model of representation**	Pluralist (popular (supra) national election and lobbying)	Pluralist (popular local election and lobbying)	Corporatist (formalized public-private governing arrangements)	Partnership (Participatory public-private governing arrangements	Partnership (Participatory private-private governing arrangements)
	Rules of interaction	Formal rules (rule of law; fixed and clear procedures)	Formal rules (rule of law; fixed and clear procedures)	Formal and informal exchange rules	Institutions in its broadest form (Formal and informal rules)	Informal rules (norms; culture); Self-crafted (non-imposed) formal rules
	Mechanisms of social interaction	Top-down; command-and-control	Sub-national governments decide autonomously about collaborations within top-down determined boundaries	Private actors decide autonomously about collaborations within top-down determined boundaries	Interactive: social learning, deliberations, and negotiations	Bottom-up: social learning, deliberations and negotiations
Features concerning content	**Goals and targets**	Uniform goals and targets	Uniform and level specific goals and targets	Uniform goals; targets actor specific	Tailor-made and integrated goals and targets	Tailor-made goals and targets
	Instruments	Legislation, permits, norms and standards	Public covenants and performance contracts	Incentive based instruments like taxes and grants; performance contracts	Negotiated agreements; trading mechanisms; covenants; entitlements	Voluntary instruments; private contracts; entitlements; labelling and reporting
	Policy	Sectorial	Sectorial	Sectorial	Integrated	Sectorial to integrated
	Integration	(policy sectors and levels separated)	(policy sectors separated)	(branches and industries separated)	(policy sectors and policy levels integrated)	(depends on problem framing by communities of interest)
	Policy-science interface	Primacy of generic, expert knowledge	Primacy of generic expert knowledge. Room for issue and time-and-place specific knowledge	Dominance of issue and time-and-place specific knowledge; expert and lay (producers and consumers)	Transdisciplinarity: expert and lay knowledge in networks. Emphasis on integrated and time-and-place specific knowledge	Dominance of issue and time-and-place specific: expert and lay (citizens)

→ = dominant role; ←→ = equivalent role; - - - = background role;

S = central state; s = decentralized state; m = market; and cs = civil society

Table 3: Modes of (environmental) governance an key features (Driessen, et al., 2012)

2.2 RESEARCH STRATEGY & METHOD

In order to understand how the LCD strategy was developed, implemented and what stimulated its success, a *qualitative case study* methodology was chosen. A case study is a well-documented and systematic examination of the process of decision-making and/or outcomes of a project, which is undertaken for the purpose of informing future practice, policy, theory, and/or education (Gerring, 2004). Such a qualitative approach is preferred in this research because the aim is to identify the underlying mechanisms (stimulating factors) and measures of successful low-carbon development within the boundaries or European cities. Several of Gerring's propositions for appropriateness of a case-study approach apply to this research, namely that inferences are descriptive rather than causal, propositional depth is prized over breadth, insight into the causal mechanisms is more important than insight into causal effects and that the strategy of research is exploratory, rather than confirmatory. Lastly, a case-study approach is used in light of time and resource constraints. By incorporating semi-structured interviews and a comparative case approach, the research systematically investigated the relative importance of driving factors of LCD in the urban environment.

In this study the research strategy is composed of a three-phase approach (Figure 3):

- The first phase entailed the further refinement of the analytical framework. The analytical framework is based on theories related to sustainable development, project management, environmental governance and technology. The framework was further refined and combined with the use of scientific literature and a relevant actor;
- The second phase focused on the comparative case analysis. Data was gathered from those selected cases trough desk-research and field-research. Interviews were held with key actors involved in the different cases to gain insight on their perspective and experiences in relation with driving factors for LCD. Based on the analytical framework, key actors were presented with the stimulating factors of the analytical framework and asked to rank them according to their relative importance in the LCD strategy;
- The third phase focused on the analysis of the data, and finally the conclusion of the results from literature review and comparative case studies will be presented.

Aligned with the exploratory nature of this research, interviews are chosen as an important data collection method in order to better understand the driving processes of different LCD strategies in different national- and socio-economic, politico-institutional and technical contexts. The advantages of interviews in this research are that it (Verschuren & Doorewaard, 2005):

- allows for in-depth investigation of underlying mechanisms;
- allows for a detailed record of experiences, opinions and perceptions of LCD processes;
- investigate the use, effectiveness and usefulness of particular library collections and services;
- increases the chances of a high response rate;
- allows for the recording of information for later analysis, allowing the researcher to focus on the discussion;
- allows for the clarification of questions or answers and incomplete answers can be followed up.

The main disadvantages of interviews are that they:

- can be very time-consuming and labour-intensive;
- can be costly;
- different interviewers may understand and transcribe interviews in different ways;
- can include interviewees providing *strategic answers*.

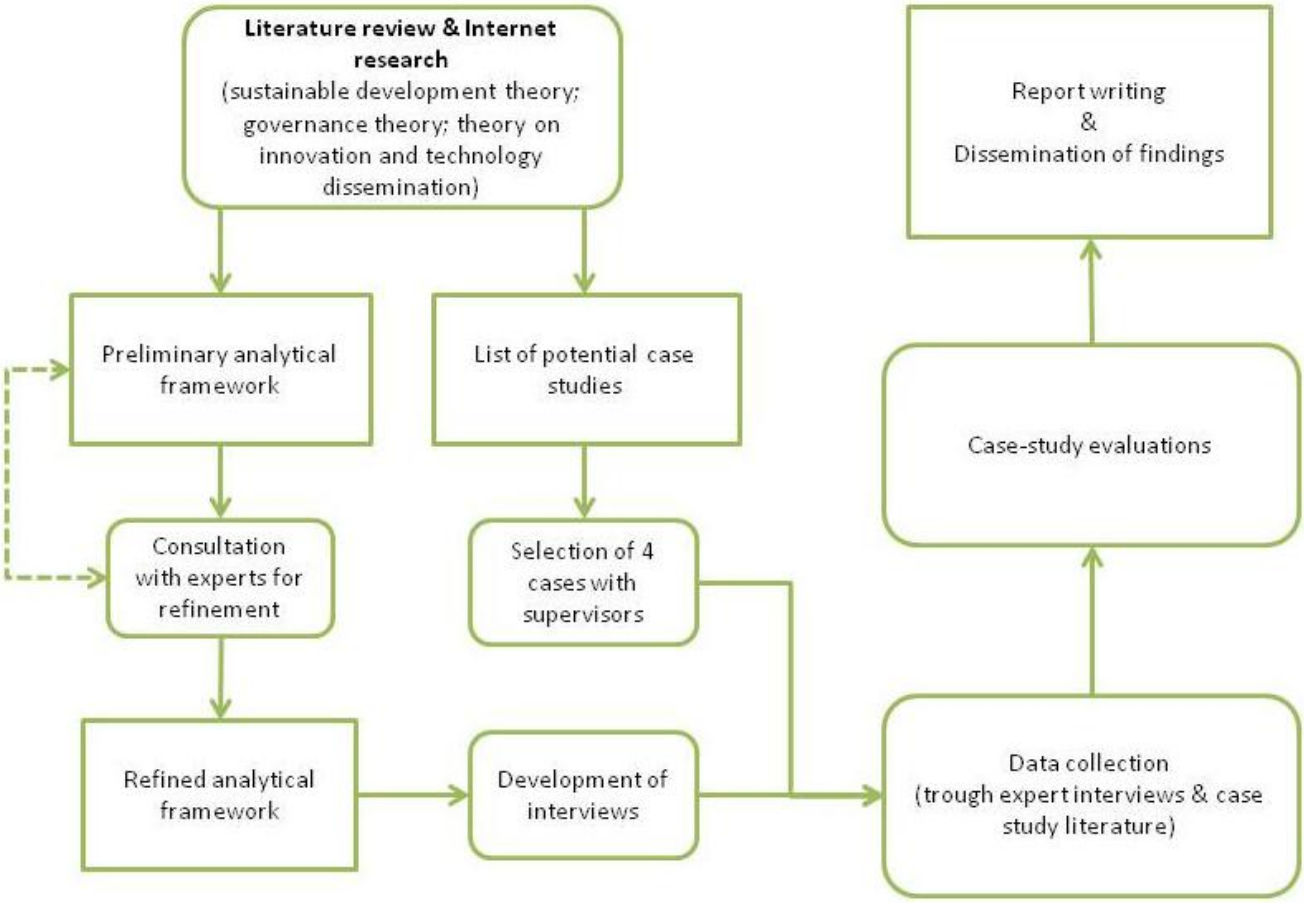


Figure 3: Research strategy

2.2.1.1 CASE SELECTION

Figure 4 shows the process of case selection. Through a preliminary literature review and internet research, combined with a list of predefined criteria (Table 4), a list of possible case studies for the research was prepared. For each case a contact was found which was approached via e-mail or phone inquiry. In consultation with the supervisors[12] from TNO and University Utrecht, a selection of cases has been made (Table 5). The contact persons of this list were contacted in order to gain first insight into the case and to conduct a preliminary check on the analytical framework. The contact persons were asked why the selected project can be seen as successful and what they believe to have shaped their success. Moreover, a list of stakeholders was constructed through the snowballing method[13].

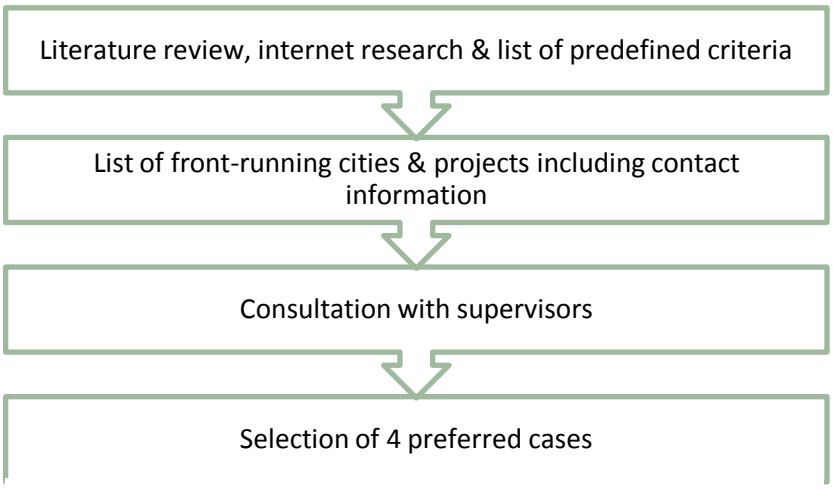


Figure 4: Case selection process

[12] Kees van Deelen (TNO) and Peter Driessen (UU)

[13] A non-probability sampling technique where the first contact proposes future subjects from among their contacts

Table 4: Case selection criteria

Case Selection Criteria (design)	Description
Location within Europe	As a supportive and preliminary research for the European network "EURBANLAB", the selected cases for this research must be European in order to enhance the external validity of the results.
Low-Carbon transition	The central aim of the case, or a significant subset of the case, is/was aimed at attempting to reduce the emission of CO_2.
Urban area	The case must be in an urban area, either be villages or cities.
Redevelopment (brown- and/or greyfield)	Only redevelopment (urban regeneration and neighbourhood renewal projects) which seeks to address climate change trough CO_2 reductions will be considered. Greenfield developments are therefore excluded from the research.
Case Selection Criteria (practical)	**Description**
Strategies are completed or being implemented	Only cases which have completed their development trajectory or are in the process of completing the trajectory will be selected. Cases which are still in the planning phase will therefore be excluded from the research.
Neighbourhood level	Schemes which seek to renew and redevelop existing urban layouts or structures at the neighbourhood level in order to reduce energy use in the city (justification in chapter 1).
One of the projects must be in the Netherlands	For practical reasons and restricted resources, one of the cases must be located in the Netherlands.

The selected cases (Table 5) are situated in 'successful cities' and have a significant low-carbon component. Cities are seen as successful in the sense that policy measures have successfully guided the implementation of low-carbon practices, either technological- behavioural or otherwise constitutive to a reduction in carbon emissions. In order to analyse why these projects were successful in low-carbon urban development, a neighbourhood-level case study in four of the cities was conducted. Analysing the implementation of a certain project at the neighbourhood level provides in-depth insight into the stimulating factors of implementing LCD-strategies locally, for the fulfilment of ambitions at the city or national scale.

Table 5: Selected case-studies

Country	City & District	Description	Development stage
Sweden	Stockholm, Hammarby Sjöstad	An old harbour and industrial area has re developed into a modern and eco-friendly district. Hammarby Sjöstad is Stockholm's largest urban development project with its own environmental programme incorporating energy supply, water and wastewater treatment and waste management.	Implementation (already inhabited, due to be fully completed in 2017)
United Kingdom	London, Hackbridge (South London)	Beddington Zero Energy Development (BedZED) is the UK's first and largest carbon-neutral mixed use sustainable community and has received many awards.	Completed
Netherlands	Amsterdam, GWL-Terrein	GWL-Terrein is a car-free brownfield redevelopment with limited parking, car-sharing provision and good transit access. Non-motorized mode share in the development is much higher than the surrounding area and car use is much lower.	Completed
Germany	Vauban	Vauban is a neighbourhood of 5,000 inhabitants, located 4km south of Freiburg town centre. It was built as a 'sustainable model district' on the site of a former French military base. Low-carbon technologies include heating from a combined heat and power station, solar collectors, and photovoltaics. Vauban is estimated to be one of the largest solar districts in Europe.	Completed

2.2.1.2 DATA COLLECTION

Data was gathered using the above described analytical framework through a combination of desk-research and a cross-national comparative case study approach.

Next to an extensive literature research on low-carbon urban development, an initial interview was conducted with a relevant actor[14] to get a preliminary understanding of the possible stimulating factors for low-carbon development, and to verify the concept of the analytical framework.

Data collection for the different case studies primarily focused on the available literatures such as official documents, reports, published academic articles, brochures and policy documents. In addition to the desk-research for the case studies in Sweden, the United Kingdom and the Netherlands, interviews with a number of actors (mainly key actors - but also a few secondary actors and residents) were conducted. Furthermore, these cases have been visited to appreciate the look and feel of the area developed. For the Dutch case-study, a total of eight interviewees were consulted. For the case study in the UK, three interviewees were willing to provide additional information. Eight interviews were conducted for the case study in Sweden, seven in person and one over the phone.

Unfortunately, it proved to be difficult to find interviewees for the German case study. The chapter on Vauban is therefore largely based on the available literatures. However, to validate the results, the case description was sent to two independent experts[15] who have read and corrected the case description before being incorporated in the final report (see appendix A: Overview of interviewees).

After the interview with relevant actors, the interviewees were asked to rank a number of predefined stimulating factors according to their relative importance in the success of the project. The interviewees were presented with a set of cards, each describing a stimulating factor. The interviewee was then asked to assign weights to the factors they consider to be most important in the success of the project. They were asked to sort the cards in three categories: '*determinative'* (i.e., absolutely essential to the success of the LCD), '*important*' (yet not determinative), and '*not important*'. The input and reasoning behind this exercise was used to supplement the available literatures on the different case-studies. Although the interviews were semi-structured, the element of discussing a respondent's reasoning for choosing and assessing a certain factor inserted an open character to the interview and provided additional information.

Interview protocol

Interviewees were chosen as much as possible to get a representative source of information from three general groups. First, the *governmental group* which, for example, can include representatives from the municipality or province. Second, the *project managers or project owners group* which includes actors which have been present in the design, implementation or stimulation of the project. Third, *third party groups* which have been actively involved in the project such as non-governmental organizations (NGO), consultants or citizens. Respondents were selected on their involvement in the project, meaning that respondents need to have been directly involved in the project. Respondents were thus selected beforehand and asked if they are willing to participate. Prior to the interview then, an introduction e-mail was sent to each of the respondents. This letter contained the objective of the interview, the context and required time.

As all interviews were to be recorded, at the start of the interview the interviewee was asked for permission to record the interview. Before starting the ranking of the factors, some general information and open questions are asked. A few examples of interview question can be found in appendix B: Interview questions.

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[14] Martin Dubbeling is a senior consultant, urban planner and urban designer at SAB in Arnhem, The Netherlands, and former bureau member of ISOCARP and board member of the Netherlands professional organisation of spatial planning and urban design. Moreover, Martin Dubbeling was Rapporteur and member of the Congress Team on the 45th ISOCARP congress 'Low Carbon Cities' in Porto in 2009.

[15] Ted Petith (independent renewables and environmental professional consultant at 'MadiSUN') and Meinhard Hansen (Passivhaus Architect living in Vauban).

3 CASE STUDY ANALYSIS

The following paragraphs will analyse the case studies in this research.

Case Study

Hammarby Sjöstad, Sweden

3.1 HAMMARBY SJÖSTAD (STOCKHOLM, SWEDEN)

During the so-called 'green wave' in the 1960s, many of Stockholm's residents moved out from to city to live a more environmentally friendly rural lifestyle. During the following decades this notion changed and city life, with its high-density housing and provision of public transportation, again attracted a growing population to the inner city.

During the early 1990s, the City Planning Administration of Stockholm became aware of the growing population in the city and predicted a continuing trend into the new century. Many of the urban districts built during the years after the war proved to be unsustainable forms of urban development and tend to house more deprived communities than other parts of Stockholm. Rather than repeating the same issue, the City Planning Administration decided to identify several areas across Stockholm for re-development, the majority of which were ex-industrial sites. Rather than building new suburbs, these developments were meant to be extensions of the inner city of Stockholm.

Hammarby Sjöstad (HS) is a large brownfield mixed-use urban regeneration project guided by extensive environmental objectives. The area extents over 160 hectares of land and 40 hectares of water, replacing an old industrial and harbour area around Stockholm's 'Lake Hammarby' (Kasioumi, 2011). It is worth noting that "contrary to the situation in other European brownfields, very few sites in HS had been abandoned" (Vestbro, 2004, p. 2). Although it was a well-functioning industrial area, it was classified as a potential residential area because of its location close to the city centre. Because of its size, the development is carried out in twelve phases (see figure 1). Construction began during the 1990s and about seventy per cent of the development has been completed. When fully developed in 2015, the development is projected to accommodate 35,000 people in 9,000 housing units and around 400,000 square meters of commercial and offices space (Kasioumi, 2011).

Hammarby Sjöstad approaches sustainability in an integrated manner, incorporating a wide range of sustainability measures in the development. This integrated approach has led, not only in concept but in as well in terms of measurable outcomes, to the acceptance of HS and its ambitious environmental program as a successful model of sustainable urban development (Kasioumi, 2011; Iverot & Brandt, 2011).

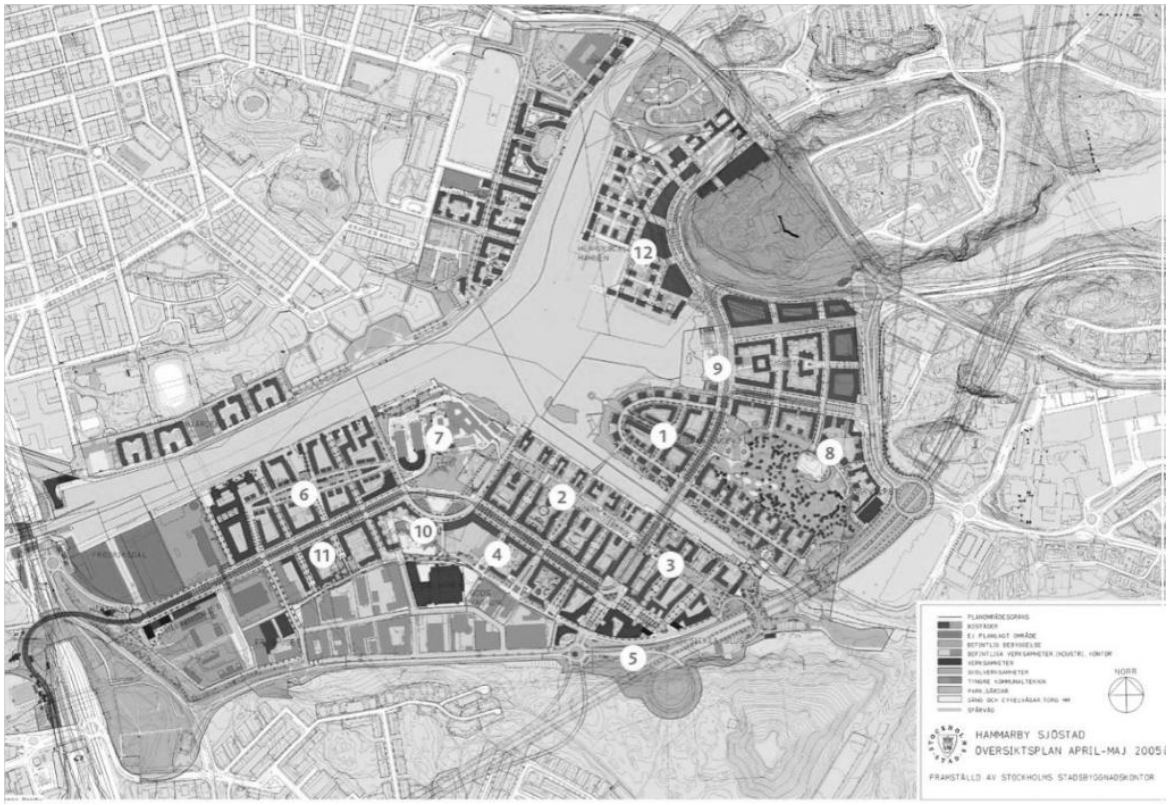


Figure 5: Hammarby Sjöstad master plan

(Kasioumi, 2011)
Numbers correspond the project phases. 1: Sickla Udde; 2: Sickla Kaj; 3: Sickla Kanal; 4: Kölnan; 5: Sjöstadsporten; 6: Hammarby Gard; 7: Luma; 8: Forsen; 9: Lugnets; 10: Godsfinkan; 11: Proppen; 12: Henriksdalshammen.

3.1.1 CHARACTERIZATION OF THE PRACTICE IN PLACE

The following chapter will describe the key elements of Hammarby Sjöstad. It aims to provide an overview of the LCD strategy by discussing the "*field of activity*", "*government & project ambition*", "*implemented technologies*" and the "results & problems in use".

3.1.1.1 FIELD OF ACTIVITY

Hammarby Sjöstad is possibly most famous because of the "Hammarby Model" which was designed to achieve the aims and goals of the environmental program. The Model handles energy, waste, sewage and water, aiming to turn the linear urban metabolism, which consumes inflowing resources and discards out-flowing wastes, into a cyclical system which optimizes resource use and minimizes waste (Suzuki, et al., 2010).

Transport

The development of HS included several transport investments including increased bus service (inner-city buses are fuelled by biogas), cycle paths, pedestrian bridges, a free ferry service, and an extension of the tramline. To discourage private car use, parking in the area is limited, priced and 37 low emissions car-sharing cars with dedicated parking spaces are now located in Hammarby Sjöstad (ITDP, 2011).

Waste and Water

Solid waste is collected through an ENVAC waste system via a network of underground pipes to central points for collection. Combustible waste, paper, organic waste and other wastes are separated and deposited in different refuse chutes that are linked to the underground vacuum-powered waste system.

Rainwater is separated from the sewerage system to improve the quality of wastewater and sludge for the biogas installation. Rainwater and storm water is collected, purified through a sand filter and released back into the lake, 'Hammarby Sjö'. A pilot sewage treatment plant facility has been built which, to date, is testing four new and different processes of sewage treatment techniques (Suzuki, et al., 2010). Biogas is then extracted from the digestion of sewage sludge. Households in HS are not billed individually for the consumption of water.

Urban Land Use and Spatial Structure

Hammarby Sjöstad had a focus on sanitary redevelopment, reuse and transformation of an old brownfield site into attractive an attractive residential areas with beautiful parks and green public spaces. Great emphasis has been placed on the choice of environmentally friendly materials and the production of such products in the development of Hammarby Sjöstad (Grontmij, 2008). Throughout the development, only sustainable and tested eco-friendly products are used and potentially hazardous materials are avoided to prevent discharges of dangerous substances into the environment (Suzuki, et al., 2010). Roofs are covered in stonecrop or sedum plants, which absorb rainwater and add to the aesthetics of the area.

Energy

District heating, cooling and electricity is supplied to Hammarby from two main sources. In short, all constructions in HS are connected to a district heating system that is fired by a, domestic waste fuelled, combined heat and power plant (CHP). The CHP converges treated wastewater and domestic waste into sources for heating, cooling and electricity (Suzuki, et al., 2010). Through the incineration of combustible waste, district heating and electricity is generated. The wastewater treatment process supplies the district with heating and cooling. Solid waste and wastewater still contain heat that can be extracted and upgraded with a heat pump after the treatment process, which is then fed into the district-heating network. The remaining cooled water can be used to lower the temperatures in commercial and office areas. The resulting sludge from the wastewater treatment process is digested to produce biogas that can be used for cooking and transportation. In short, waste generated in the district is fed back into the district as practical energy (ibid).

Solar energy in the district is converted into electricity through solar cells and panels. Many of the solar panels in the district are used to heat water, which often provide sufficient energy to meet half of the annual hot water

requirements of the building.

Biogas is produced in the wastewater plant from the digestion of organic waste and sludge. One household's wastewater produces sufficient biogas to fire the household's gas cooker. However, most biogas is used to fuel inner-district busses and eco-friendly cars (ibid).

3.1.1.2 GOVERNMENT & PROJECT AMBITION

At the *national level*, Sweden has often been considered a forerunner in environmental policy and implementation (Khakee, et al., 2008). After the Rio conference in 1992 the Swedish government supported the resulting Agenda 21 document by appointing a National Commission in 1995 to help develop and establish the agenda in Sweden. In June 2000, a National Commission on Agenda 21 and Habit was appointed to support and develop implementation of both Agenda 21 and the Habitat Agenda (ibid).

At this point in time, however, the national government mainly stressed the environment dimension of sustainable development. The Swedish Prime Minister, in his 1996 statement of government policy, stated that the country should be a driving force and a model when it comes to efforts to achieve 'ecological sustainability' (Femenías, 2004; Khakee, et al., 2008). This ambition was not only present in governmental documents but was also stressed by the appointment of a new commission in 1997, named The Commission on Ecologically Sustainable Development, to deal with sustainable development. Until the end of the 1990s the Swedish government emphasized environmental aspects in sustainable development and, in relation to planning, the Swedish Parliament approved the 1999 policy document 'Fifteen Environmental Quality Objectives'. These principles (Table 6: Sweden's fifteen national environmental quality objectives) were to be included in all planning and construction procedures (Femenías, 2004). Although several other objects directly or indirectly affect building activities (cursive in Table 6), objective fifteen "a good urban environment" specifically addresses the built environment and the building sector.

However, because environmentalism in Sweden originated out of the sciences instead of ideologies and radicalism as is generally the course in other European countries, Swedish environmental policy has been coloured by rationalistic and science-based deliberation[16]. As a result, Swedish environmental policy has often been portrayed as strongly rationalistic and realist, in which scientific deliberation dominates in the policy making process. Although efforts at the national and local level to promote the integration of environmental conditions in different planning and programming contexts have led to progress in some areas, the ambition to integrate environmental concerns and implement sustainable development continues to make slow progress (Khakee, et al., 2008, p. 83). Regardless of the expectation that all sectors of society contribute to sustainable development, national directives and policy measures are often designed from a macro perspective, often neglecting conditions and difficulties that might appear at the micro level (ibid). Despite the obvious sectorial nature of both the public administration and of society in general, sector interests are presupposed to be compatible. In many situations, the national government failed to anticipate the resistance at the local level in response to national top-down incentives and environmental considerations remains a conflict-laden issue when different sector interests are weighed in (ibid).

After a weakening trend at the end of the 1990s, the national focus on sustainable development has intensified again (Khakee, et al., 2008). The Swedish Government presented their Climate Bill "A Swedish Climate Change Strategy" in November 2001, expressing the ambition to reduce GHG-emissions by 4% during 2004-2012 as compared with 1990 levels (Gustavsson, et al., 2009). In the strategy, Swedish municipalities are defined as important actors in an "integrated central-local government system, giving substantial financial, constitutional, legal, political, and professional resources to local government" (ibid: p. 63). Sweden does not have a mandatory climate policy but relies on incentive programs requireing cooperation between actors from both the public and private sectors (ibid).

[16] See for example Strandberg (2005) in: "Which environmental problems get policy attention? Examining energy and agricultural sector policies in Sweden", by Engström, et al., (2008).

Table 6: Sweden's fifteen national environmental quality objectives

1. *Reduced Climate Impact*	9. *Good-Quality Groundwater*
2. *Clean Air*	10. A Balanced Marine Environment, Flourishing Coastal Areas and Archipelagos
3. Natural Acidification Only	11. Thriving Wetlands
4. *A Non-Toxic Environment*	12. *Sustainable Forests*
5. *A Protective Ozone Layer*	13. A Varied Agricultural Landscape
6. *A Safe Radiation Environment*	14. A Magnificent Mountain Landscape
7. *Zero Eutrophication*	15. A Good Built-Environment
8. Flourishing Lakes and Streams	

Several national laws and regulatory incentives shape the arena for sustainable development, in particular sustainable building. After the new Environmental Code came into force in January 1999, all planning and building activities are to consider issues such as sustainable resource efficiency (water, land and energy) and natural resources, and use 'the best available technologies' in their development. The law should ensure a good living environment for current and future generations and provides nature with its proper value of protection (Femenías, 2004).

Based on the already established objectives and decisions, the first National Strategy for Sustainable Development[17] has been formulated in 2002. The government pointed out eight strategic areas for major concern. In relation to the built environment and with a focus on energy efficiency, the strategy emphasizes a good living environment through the use of good techniques, system solutions, environmentally adapted building and effective management (ibid).

Table 7: Sweden's commitments to international treaties on Climate Change (Ministry of the Environment Sweden, 2010; ICLEI, 2012c)

(International) treaties on Climate Change	Ratified/Signed?	When?
UN Framework Convention on Climate Change (UNFCCC)	V	1993 (signed in 1992, went into force in 1994)
Kyoto Protocol	V	2002 (signed in 1998, went into for in 2005)
Agenda 21	V	1992

Table 8: Sweden's ambitions (Ministry of the Environment Sweden, 2010)

Topic	Year	Target/Value
Renewable energy	2020	50%
Energy efficiency	2020	20% reduction
Greenhouse gases	2020	40% reduction
Heating	2020	No use of fossil fuels for heating in the housing sector
Fossil fuel use	2050	Fossil-fuel-free

During the late part of the 1990s, several programs with economic support for environmental investments were launched by the Swedish Government. Most notably was the LIP-Program (1998-2002) which aimed to stimulate the modernization of buildings, infrastructure and energy systems at the local level (Femenías, 2004). One requirement to receive the financial support has been the cooperation with different partners.

[17] The Strategy has been revised into the Swedish Strategy for Sustainable Economic, Social and Environmental Development in 2004.

Progress towards Kyoto target

Based on its domestic emission levels only, Sweden was on track to meet its burden-sharing target at the end of 2010 (EEA, 2011). The average 2008-2010 emissions were 13.2% lower than the base-year level, and well below the burden-sharing target of 4% for the period 2008-2012. When analysing the sectors not covered by the EU-ETS[18], average emissions were with 17.7% significantly lower than their respective base-year target emissions (ibid).

At the *local level*, the city of Stockholm is known for its environmental focus and won the European Green Capital competition and was recognised as Europe's 'greenest 'city. Stockholm is involved in several international treaties (see Table 9). Moreover, Stockholm has adopted the objective of being fossil fuel free by 2050 (ICLEI, 2012c).

Table 9: Stockholm's commitments to (international) treaties (ICLEI, 2012c; European Commission, 2012)

Treaty	Signatory?	When?
ICLEI –Local Governments for Sustainability	V	1991
Covenant of Mayors	V	2008
Aalborg Charter	V	
Aalborg Commitments	V	

Project ambitions

The environmental program, specifically designed for HS, contains the ambitions and targets for the development. It was intended to work as a planning tool, coordinating the development and to create consensus on different objectives (Iverot & Brandt, 2011). The program aimed to reduce the metabolic flows of the district to a minimum and incorporated a guiding vision of HS. As mentioned, Hammarby Sjöstad approaches sustainable urban development in a holistic manner. The project thus set out to meet a variety targets such as water conservation, waste reduction and reuse, emissions reduction, the reduced use of hazardous construction materials, the application of renewable energy sources, and the implementation of integrated transportation solutions.

The overall vision of the city of Stockholm for Hammarby Sjöstad was to create an urban district with a reduced environmental impact of 50%, which would use half the amount of energy used in contemporary new urban areas dating from the early 1990s in Stockholm (Gaffney, et al., 2007; Kasioumi, 2011).

''The environmental performance of the city district should be twice as good as the state of the art technology available in the present day construction field. As work progresses, the stated operational goals must continue to evolve in this specific direction. In order to achieve these goals lifestyles need to be re-examined, new technological solutions developed, and a more holistic view of planning implemented.''

(City of Stockholm, 1996, p. 4)

[18] Under the so-called 'Effort Sharing Decision', Member States have taken on binding annual targets for reducing their greenhouse gas emissions from the sectors not covered by the EU ETS, such as housing, agriculture, waste and transport (excluding aviation). Around 60% of the EU's total emissions come from sectors outside the EU ETS (EEA, 2011).

The overarching vision was further clarified by the formulation of overarching aims such as statements that transport needs to be reduced and energy should primarily be derived from renewable sources and as local level as possible (City of Stockholm, 1996, p. 7). These aims were then rendered into practical goals, divided into nine different categories (see Table 10).

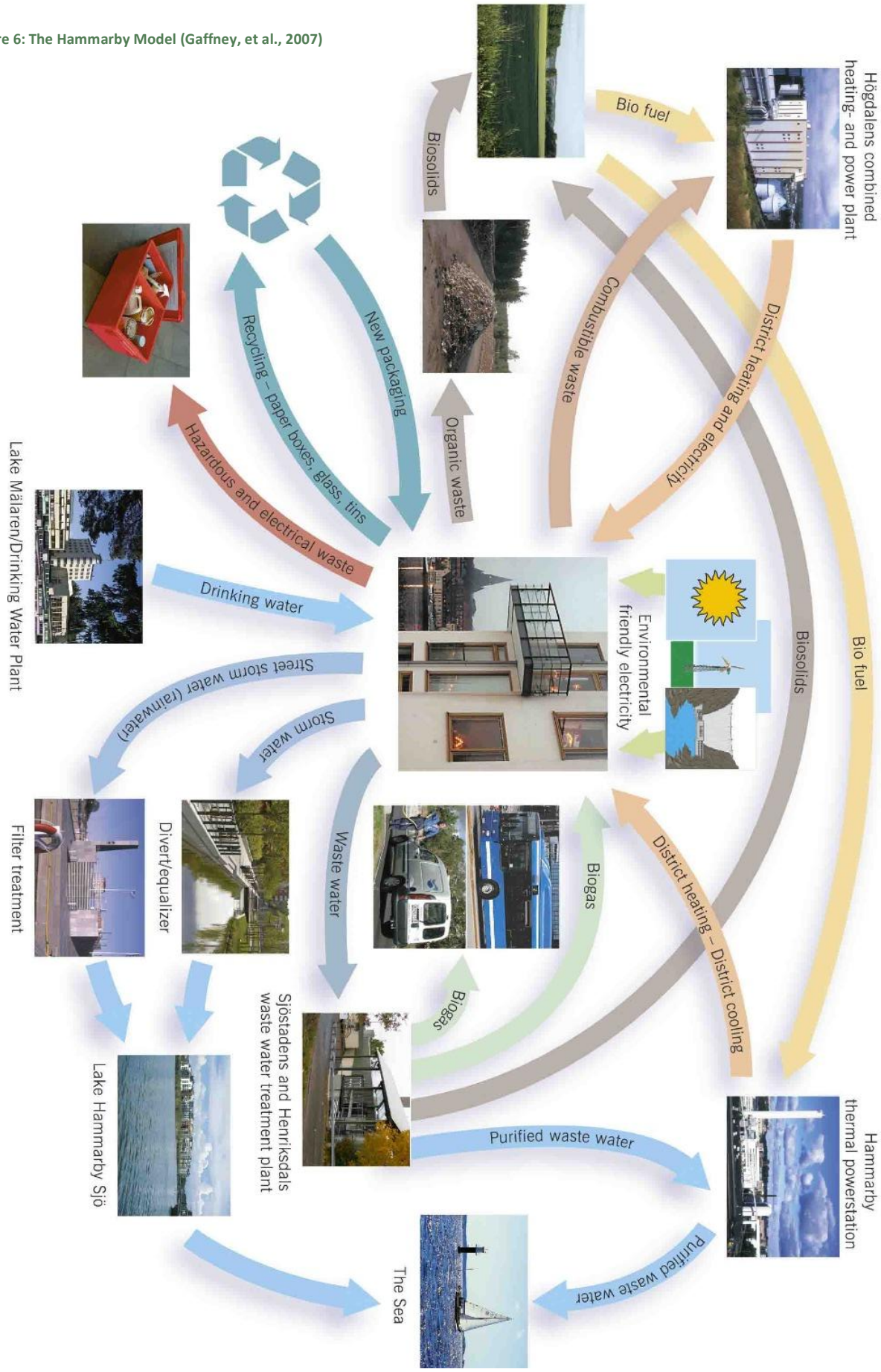
Table 10: Examples of operational goals (City of Stockholm, 1996 in: Iverot & Brandt, 2011, p. 1052)

Category	Example of operational goals
Energy	"The total requirement of supplied energy is not to exceed 60 kWh/m^2 of which electricity is not to exceed 20 kWh/m^2 and the total being the sum of all residential energy consumption that includes energy from solar cells/ collectors." (p. 15)
Transportation	"80% of all commuting using public transport, cycling or walking." (p. 16)
Material flows (waste and recycling)	"The total amount of recyclable and waste material, both of which is the responsibility of municipal authorities and various commercial interests, is to have been reduced by 20% in weight." (p. 16)
Water and drainage	"Water consumption (excluding re-circulated water) per person/equivalent is to have been reduced by 50% compared with the average supply to new housing in the inner city area." (p. 17)
Building materials	"Recoverable materials are to be used as far as is technologically and economically possible." (p. 17)
Land use	"100% of all developed land is to be recreated within, and adapted to, the district." (p. 18)
Contaminated soil	"Areas of contaminated soil are to be sanitised prior to development, to such an extent that they no longer represent a risk to either public health or the environment." (p. 18)
Lake restoration	"All storm water from roads and parking areas is to be purified." (p. 18)
Emissions/disturbances	"All housing is to have a noise-free side, where the equivalent noise level outside the window does not exceed 40 dB (A)." (p. 18)

3.1.1.3 IMPLEMENTED TECHNOLOGIES

Numerous technologies have been implemented in HS. The most significant, however, are the CHP-plant and the production of biogas in the wastewater treatment plant. In order to save energy extra heat insulation, FX-ventilation systems, energy-efficient windows, individual metering of heating and hot water in apartments, electricity efficient installations, solar panels, solar cells and fuel cells have been installed. A special, vacuum-powered waste collection system recycles waste into four fractions. In terms of transportation, biogas-fired buses are used. In relation to the reduction of water, flow-reducing fittings and low-flow toilets have been installed in the district.

Figure 6: The Hammarby Model (Gaffney, et al., 2007)



3.1.1.4 RESULTS & PROBLEMS IN USE

To date, Hammarby Sjöstad is an attractive residential area with parks and green public spaces, and especially attractive for young families. Unfortunately, the overall environmental goal set for HS- to reduce the environmental loads by half relative to urban development loads in the early 1990s - has not been reached (Grontmij, 2008; Suzuki, et al., 2010).

Although not all of the targets reach the intended 50 per cent reduction, substantial reduction have been achieved due to effective planning for district heating, waste, urban transportation, and wastewater management (Suzuki, et al., 2010). According to Grontmij (2008)[19], the reductions range between 23 and 70 per cent for all measurements, but the primary reduction has been in the total environmental impact from buildings and zones in the development. If buildings alone are taken into account, the improvement is 40-46%. The report shows that if the total environmental impact for buildings, building plots and zones is taken into account, a reduction of 32-39% for emissions into the air, soil and water was recorded. Greenhouse gas emissions specifically were 30-40% lower in comparison with conventional newly built of the early 1990s. Table 1 below shows the further achievements in HS (for full details on the reductions see Grontmij, 2008).

Table 11: Other results in percentages (Grontmij, 2008)

Reduction type	Percentage achieved
Non-renewable energy use	28-42% (buildings alone, 30-47%)
Greenhouse gas emissions	30-40%
Over fertilization	49-53%
Ground level ozone	33-38%
Water consumption	41-46%
Acidification	23-29%
Radioactive waste	27-40%

According to the research, the activities that have produced the biggest reduction in environmental impact are: water, sewage and heating, the technical services for the properties, and the construction materials for the production of the buildings (Grontmij, 2008, p. 6). In sum, the global warming potential has been reduced by 29-37% in Hammarby Sjöstad.

Energy

Relative to a reference scenario, the results were a 28–42 per cent reduction in non-renewable energy use. Resultantly, Hammarby Sjöstad residents have a per capita carbon footprint of 5-3 tonnes per annum, compared with 4 tonnes for those living in Stockholm city (Williams, 2012).

However, the target for energy consumption was set at 60 kWh/m^2/year, but a subsequent assessment by Grontmij (2008) showed that actual consumption is closer to 120 kWh/m^2/year. According to the assessment, a combination of factors have led to the doubling of the target; including different user behaviour than anticipated and occasional prioritisation of comfort over energy saving in the design of HS.

[19] The research focused on four representative fully built districts of Hammarby Sjöstad: Sickla Udde, Sickla Kaj, Lugnet and Proppen.

Transport

Overall, the Environmental Impact Profile report by Grontmij (2008), showed that a considerable part of the reduction in environmental impact is achieved by measures taken in the transport sector. Particularly changes in personal transport modes, where the light rail and ferry play an important role, have reduced the CO^2 emissions from transport per apartment by 48%. The carbon dioxide emissions from personal transport by car are thus significantly lower in HS. Figure 3 shows that the referent produces ca. 475 kg more CO2 per apartment from personal transport by than HS. This yields a total reduction of approximately 2,373 tons of CO^2 per year ((ITDP, 2011).

Approximately 0.15 on-street parking spaces per household, and approximately 0.55 spaces per household in public or private garages are present in Hammarby Sjöstad (ibid). However, parking is not evenly spread and in some places will be much lower, but the overall number for parking spaces is 0.65 per household (ibid.).

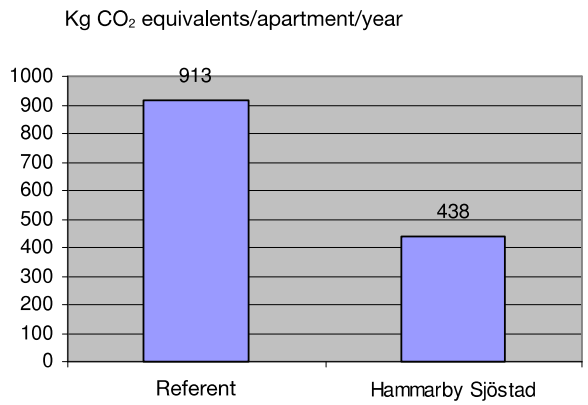


Figure 7: Carbon dioxide emissions from personal transport by car (Grontmij, 2008, p. 7)

Waste & Water

Water consumption has been reduced with 41–46 per cent and a 27–40 per cent reduction in radioactive waste has been recorded. However, water consumption per person per day currently is at 150 litres, rather than the target of 100 litres (Loftus, 2011) .

Urban Land-Use & Spatial Structure

According to Kasioumi (2011), the results of HM regarding its environmental successes are more prolific than for its social and economic features. The vision of constructing a work-live environment, for example, was only partially attained in HS. Retail and office spaces have been slow to fill, but the area is particularly attractive to young families who enjoy a healthy environment with excellent public spaces and facilities.

Moreover, although Hammarby Sjöstad has been easily marketable, the development has inflated land prices, which is somewhat inflated by the balance between renters and owners (ibid: 99).

However, much of the environmental benefits are due to the design of buildings and the provision public transportation (Grontmij, 2008). As will be discussed below, the approach to planning HS engaged producers to create low-carbon technical systems rather than involving the community to help raise energy awareness and engage public interest or involvement (Williams, 2012).

Lastly, from a social sustainability standpoint, the project's ambition to create a low-carbon district which promotes social heterogeneity has not been achieved. Increasing construction costs, a shift in political direction and removal of housing subsidies have led to a sustainable district with residents mostly belonging to a homogenous group with a higher socio-economic status (Loftus, 2011).

In sum, the subsequent assessment by Grontmij (2008) found that the project has not achieved its initial ambition and target of a 50% reduction in environmental impact, but that the project does approach this reduction in certain areas.

3.1.2 DEVELOPMENT PROCESS AND GOVERNANCE

In the paragraphs below, the main characteristics of the planning process and governance approach will be discussed.

3.1.2.1 DEVELOPMENT PROCESS

Control of the planning process: main actors, roles & responsibilities

Although the area of Hammarby Sjöstad still functioned as a successful industrial area, plans were made to re-develop the area into a residential district at the beginning of the 1990s (Vestbro, 2004). However, parts of the area had fallen into disuse and unregulated industrial activity had resulted in severe contamination of the site. The heavily polluted soil was not seen as a big obstacle, but was considered as a good reason to effectively treat the contaminated soil (ibid). Concerned with the remediation of the contaminated site and the increasing demand for housing, the City Authority purchased the remaining land in private ownership. To expedite the process, the land was purchased by the city at prices above the market value (Gaffney, et al., 2007). The first detailed comprehensive local area development plan for HS was presented in 1991 by planners from the City of Stockholm.

But not until 1995, when the City Council accepted the application request from leading politicians in Stockholm to host the 2004 Summer Olympic Games, did the plans effectively take root (Svane, 2008; Kasioumi, 2011; Iverot & Brandt, 2011). Local policymakers wanted to create a role model of sustainable urban development in HS and, to support the application, an environmental program was formulated. In June 1996, the environmental program for HS was accepted by the City Council and the application for the Games was sent in August that year. (Iverot & Brandt, 2011). The development of HS started with the strategic Master Plan that was developed by the City Planning Administration. During that same year the Quality Program for Design of HS was compiled and passed, the Hammarby Model was formed, the development contracts for Hammarby Sjöstad's first development (Sickla Udde) were negotiated and its regulatory detail plan was initiated (Iverot & Brandt, 2011, p. 1051).

Unfortunately, the bid for the Olympic Games was unsuccessful, but because the planning process for the district had progressed so far, the City Council decided to continue the ambitions of the environmental program (Vestbro, 2004; Iverot & Brandt, 2011). For each of the sub-districts separate detail plans were prepared, staff came from the City Planning and Development administrations. These detail plans are legally binding and specify land-use but can also cover design, material use, landscaping, parking and conservation (ibid). In practice, negotiations with developers that determined such features took place before the plans for HS were actually finalized (Kasioumi, 2011). The plans did, however, did reflect "the municipality's principles about fair division between tenure forms and different types of developers (ibid: 101)".

The Project Team, created in January 1997, had the responsibility for the Master Plan and the environmental management of the project. According to Svane (2008) the team consisted of a head, a secretary and seven representatives from the City's Office of City Planning, Office of Roads and Real Estate, and Office of Environment, and the municipal companies for energy and waste. The team had an independent economy and could make autonomous planning decisions. In preparation of the detailed Master Plan, a design process named "parallel sketches" has been adopted. Supervised by the City Development Administration and the City Planning Administration, a number of architecture firms and 40 building contractors were selected and worked on the further development of each sub-district. The Master Plan focused on the infrastructure of the project and included some ambitious environmental targets.

The project organisation was resourceful in gathering actors from different sectors and in combining different external and internal inputs to the project (Iverot & Brandt, 2011). Several environmental

competitions were initiated to encourage developers to find new sustainable technological solutions in the construction process, and the formation of the Hammarby Model and the GlashusEtt[20] was facilitated by the project organization.

The above shows that the responsibility for planning rested upon the City Planning Administration, but was done so in collaboration with private and public agencies. The planning process of Hammarby Sjöstad shows a high degree of local authority leadership with resources primarily coming from the City Planning and Development Administrations. Planning control over implementation thus exemplifies proactive planning (Kasioumi, 2011). Moreover, by gradually releasing lots, the planning administrations ensured that no one developer could influence the process or outcome and achieved sustainable outcomes by executing them in design and infrastructure or by setting the context for the private sector to do so (ibid., p. 102).

Vision, goals & means

In the development process a goal-oriented approach has been adopted in which quantifiable targets have been set in order to focus on measurable outputs. The city of Stockholm, in its pursuit of becoming a sustainable city, has developed a comprehensive urban vision, environmental programs, and concrete action plans to reduce greenhouse gas emissions and tackle climate change (Suzuki, et al., 2010, p. 183). These designations, together with the motto to build the city inwards, "were a reflection of planners' will to pursue an environmentally conscious urban form, and of politicians' support for traditional urban qualities". With its integrated approach to urban planning, ecological benefits and efficient use of resources were considered in the development of HS. The overarching vision to be "twice as good" had influential attributes as it served as a powerful tool to communicate the goals, both externally as internally, bring together the various actors from different sectors in the project, and inspired actors to try new technical solutions. Moreover, the overarching aims and operational goals influenced the choice of technical solutions and created a focus on environmental issues (Iverot & Brandt, 2011).

However, the formulation process for the operational goals has been described as insufficient, rendering a number of goals vague, unrealistically ambitious and difficult to evaluate as several goals lacked reference values or a baseline to compare the obtained results with (Iverot & Brandt, 2011). Loftus (2011) further emphasized that, in the formulation of the goals, the fact that all flows in the district are fundamentally linked and affected by the behaviour of its residents, was not taken into account. Moreover, goals were not entirely set from the beginning as the environmental program was introduced late in the planning process. The program, containing the vision for HS, was only accepted after the bid for the Olympic Games in 1996 yet comprehensive planning for HS was already initiated around 1990 when potential developers for Sickla Udde were identified by a preliminary land designation (Iverot & Brandt, 2011, p. 1054).

However, when Stockholm lost the bid for the Games to Athens, the environmental program ended up with a less prescriptive character (Kasioumi, 2011; Iverot & Brandt, 2011). The Project Team was reluctant to impose the goals and devised softer strategies like information campaigns, seminars for architects and prepared an Environmental Design Guide. Subsequently, the Project Team at times treated the environmental targets as negotiable aims rather than fixed quantifiable targets when construction companies resisted the more demanding environmental targets (Cederquist, 2012). However, despite these setbacks, the "twice as good" imperative exerted a powerful influence on the subsequent process.

The highly technological nature of HS to achieve the overarching vision and goals is the result of the focus on environmental issues in the development process (Iverot & Brandt, 2011). Although the range of technologies used was not entirely new, most of the technologies had not been implemented on such a large scale (Vernay, 2012). The innovative part of HS lies in the integration of all technologies into one system through the Hammarby Model.

The funding body for the project consist of the City of Stockholm, Stockholm Transport, the National

[20] The GlashusEtt is an environmental communication and information centre at Hammarby Sjöstad. As an example, the centre is situated in an ecologically innovative building to spur awareness amongst residents and visitors of HS.

Road Administration, private funding and refinancing through the sales of the lots (Kasioumi, 2011, p. 101). Although its success as an incentive for builders and contractors is debated (Loftus, 2011), the project received additional funding through the Local Investment Program (LIP), a subsidy offered by the Swedish national government. The LIP was meant to spur the adoption of new environmentally sustainable technologies and knowledge. The LIP was intended to run between 1998 and 2000, but was extended to 2004. Stockholm applied for the LIP in 1998 and received 678 million kronor (67 million Euros) for the city (Gaffney, et al., 2007). Stockholm allocated about SEK 200 million (21 million Euros) to Hammarby Sjöstad. Originally the LIP subsidy covered 30% of the additional costs incurrent by proposal adopting a sustainable plan, but when competitors complained about the limitation, the funding was increasing to 30% of the entire cost of accepted projects (ibid: 30).

In total, the project has been estimated to cost between 1.7 and 2.2 billion Euros (Loftus, 2011). Twenty per cent of the financing for the project was contributed by the City of Stockholm, with the twenty five construction companies involved in the project financing the rest of the budget (Loftus, 2011).

Performance monitoring

An environmental assessment tool, the Environmental Load Profile (ELP), has been developed by the City of Stockholm, the Royal Institute of Technology and the consultancy form Grontmij AB (Suzuki, et al., 2010). Primarily developed to assess the 'twice as good' target and the overall environmental performance of Hammarby Sjöstad, the ELP is a life-cycle based assessment tool which quantifies the environmental loads originating from relevant activities in the district. It accounts for all of the project developments and implementation activities, construction methods, electricity, heating, materials recycling, transportation and material acquisition (ibid).

According to Suzuki, et al., (2010, p. 159) the monitoring in Hammarby Sjöstad "has contributed to the technical and economic understanding of approacitate societal financial environmental measures in the continued development of the district." However, later research also reported on the weaknesses and uncertainties in the assesment process of HS. It was found that the environmental program of HS lacked clear guidelines for the assessment process and lacked a description of the allocation of responsibility related to the performance monitoring of the development (Iverot & Brandt, 2011). Moreover, ELP was the only comprehensive assessment tool used in the development of HS due to uncertainties with regards to the allocation of responsibility related to the assessment process. Furthermore, the generated results were based on theoretical data gathered in the planning stages of HS, thus deferring from actual measurements in the district and, resultantly, data specific to the performance of HS is scarce (ibid).

Moreover, Iverot & Brandt (2011) reported that feedback mechanisms regarding the achievement of aims and goals of the environmental program, were unsatisfactory during the development of Hammarby Sjöstad, and the results of the ELP were not comprehensibly presented. Similarly, the responsibility for data collection was not set from the beginning (Loftus, 2011).

Despite these deficits, the project of Hammarby Sjöstad showed its aspirations in the adoption of ambitious measurable targets and has chosen a quantitative assesmment approach. The technological focus in HS and the top-down approach exerted by the government resulted in practical targets for utilities and developers at which to aim. The government forced these actors to think of innovative solutions to meet high standards.

Transformations

The city of Stockholm has a long tradition of central command over urban planning, resulting in a civil service apparatus with a high degree of competency on urban development and planning (Cederquist, 2012). Moreover, around 40 construction partners were involved in the design and construction of the apartment blocks (Kasioumi, 2011). These developers were a mixture of privately and publicly owned companies who were building for private sale and for rent in the future. Stockholm had an important role in the project, especially in determining the roles and responsibilities of building contractors (Loftus, 2011). Because the environmental program ended up with a less prescriptive character, the responsibilities for the execution of

environmental goals were not fixed in written agreements (ibid). This ambiguity has led to contractors not following directions in some circumstances and decreased the performance by contractors (Loftus, 2011; Cederquist, 2012).

Participation & Communication

Hammarby Sjöstad strived for integrated urban planning in its design. From the start, the focus was on fostering technological competence in order to achieve the environmental goals of HS. The Environmental Program underlined the need for cooperation, active engagement of all actors and the need to build consensus in the early stages of the planning process (Kasioumi, 2011). Also in its implementation and the project office itself, integrated planning was evident as "the physical presence of staff from different authorities and administrations has facilitated communication as well as interdisciplinarity" (Loftus, 2011, p. 3). However, through a top-down approach the City of Stockholm involved mainly powerful actors in the planning process including stakeholders from within the City of Stockholm, landowners, contractors, developers, administrators and operators, but participation of future residents was "practically non-existent" in HS (Kasioumi, 2011, p. 104; Vernay, 2012). Moreover, partnerships were created with private actors, but no NGO participation has been found in the project's process.

The interconnectedness of Hammarby Sjöstad's environmental goals required that sectorial and isolated approaches to sustainability were overcome. Therefore, planners embarked on alliance-building activities to foster interdepartmental coordination (ibid). The City of Stockholm included representatives for the utilities in the project team to spur support from the utility companies to implement innovative energy supply and water management schemes. Planners aided the cooperative climate by continuous communication and providing incentives such as grants to cover the surplus expenditures of innovative building (ibid). Moreover, as the project team worked together with all stakeholders from within one location, as opposed to departments being based across the city, effective communication was improved because of shorter channels of communication, accessibility and aided cooperation (Freudenthal, 2012). Regarding the fact that no citizen consultation or participation took place during the process, as a law in Sweden the government is required to publish any plans before implantation. The plans for HS were not challenged by anyone (ibid).

Especially in the first phase of the project, information was disseminated broadly via seminars for architects and developers, the ELP evaluation tool and the creation of the GlashusEtt (Kasioumi, 2011). However, as mentioned under 'performance monitoring', communication regarding the achievements of aims and goals was unsatisfactory.

Environment

A number of underlying stimulating factors in the context of Hammarby Sjöstad facilitated its implementation. These external factors, independent from the planning process described earlier, aided the development of Hammarby Sjöstad, but their acknowledgment should not undermine the importance of choices made in the planning process.

According to Kasioumi (2011, p. 106), the fact that Stockholm has large land reserves, allowed for the elimination of potential conflicts with private land owners "by choosing where to put development and circumventing the cost and delay of purchasing and assembling land." Moreover, the development of HS was facilitated by a sympathetic political climate for environmental measures with the continued presence of green parties in the City Council (Iverot & Brandt, 2011; Kasioumi, 2011). Furthermore, the importance of political support underlines the importance of political consensus as created by the formulation of an overarching vision (Iverot & Brandt, 2011).

The local population in Stockholm has certain characteristics which, in relation to urban change, openness to innovation and new ideas, and a high educational level, "have minimized aversion to change and conflicts about distribution of resources among social and environmental goals (ibid: 107)."

Lastly, the presence of an environmentally innovative industry and the choice for known technologies, minimized conflicts and uncertainty about environmental technologies. The Hammarby Model made use of

existing technologies for storm water and sewage treatment, waste management, energy, and heating that had been developed in Stockholm since the 1970s (ibid).

Continuity

Continuity of the project was affected by several factors during the development process of Hammarby Sjöstad. Despite the above mentioned political support and the fact that the city planning administrations had a certain degree of freedom in decision-making, the development of HS was not entirely without the influence of messy politics.

As reported by Vestbro (2004) political stability and shifts in coalition's majority affected the objectives in the district's development. Over the years, the political setting has shifted back and forth between the left and right wings of government with a constant green association, aiming to bring the two parties towards an environmental midpoint. There are two major parties, two middle-sized and some small parties in the 101 seat Stockholm City Council. The major parties are the Social-Democrats and the Moderates, followed by the middle-sized parties, the Liberals and the Left Party. The Green Party and the Christian Democrats are part of the smaller parties. In recent years, this coalition has been shifting from left-green (1994-1998) to right-green (1998-2002), and back to left-green (2002-2006). When the decision was taken in 1995 to re-develop the area around the Hammarby Lake, the city of Stockholm was governed by a red-green coalition; a political setting which contributed substantially to the high environmental ambitions for the development (Vestbro, 2004). However, the right-wing parties had reservations about the degree of municipal control and the role of municipal housing companies. Gaffney et al., (2007) reported that political shifts compromised the housing/social equity of the project by changes in the level of public versus private-ownership land allocations. The fact that major developers actively participated in the development of the environmental program, created acceptance amongst the right-wing parties to accept the major features of the environmental program, and led to the adoption of a comprehensive environmental program by the City Council (Vestbro, 2004). In addition, Loftus (2011) reports that the standard for parking spaces was set to 0.25 parking spaces per apartment by the ruling coalition at the start of the project. However, when the coalition changed to a more right-wing coalition in 1998, the standard was raised to 0.7.

Moreover, despite the stimulating influence by the project organization as described earlier, the governing structure for the project was described as unsuccessful in some ways by Iverot & Brandt (2011). Due to the decreased political interest in HS after the Games had been awarded to Athens in 1997 and the late arrival of the environmental program, the Project Team found it difficult to enforce operational goals and "agreed on writing the phrase 'strive for compliance' in the development contracts for Hammarby Sjöstad, making the environmental program less authoritative" (ibid: 1055).

3.1.2.2 GOVERNANCE ANALYSIS: ROLE OF THE GOVERNMENT

The city of Stockholm has a long tradition of centralised governance and central command of urban planning, consequently its civil service apparatus has a high degree of competence on urban development (Cederquist, 2012).

Characteristic for decentralised governance, the *initiating actor* for the development of Hammarby Sjöstad lies with the City of Stockholm. Becoming aware of the growing population in the city, the City Planning Administration decided to identify areas for re-development across Stockholm during the early 1990s. The City of Stockholm determined the boundaries in which market parties could operate and innovate to fulfil the cities overarching ambition for the area. The *stakeholder position* in the development of HS is thus characteristic to public-private governance, in which market stakeholders have relative autonomy within predetermined boundaries. The freedom and moderate power of action with which the Project Team influenced the practical outcomes of the planning process exemplifies the relative autonomy of actors involved. However, it should be mentioned here that most stakeholders involved were mainly public as well, being under the direct influence of the City of Stockholm. The predominant *policy level* at which key actors operated, being characteristic to

decentralised governance, were the lower levels of government, the municipality level. The formal *power base* of the key actors involved can be characterised as a mixture between decentralised and public-private governance.

Regarding the institutional features, the *model of representation* can be characterised as a combination of pluralistic (decentralised governance) and corporatist (public-private governance). During the initial stages of the project, private and public actors were only indirectly involved in decision-making trough lobbying. This is exemplified by the fact that the first detailed comprehensive local area development plan for HS was drafted in 1991 by planners from the City of Stockholm. After the lobbying support of local politicians to apply for the Olympic games of 2004, a Project Team was created who had responsibility for the Master Plan and the environmental management of the project. In cooperation with, but supervised by the City Development Administration and City Planning administration, did private building contractors and architecture firms work on the detail Master Plan. Nevertheless, the process remained within the hands of the local authority, who supervised the process. Regarding the *rules of interaction*, the planning process for HS was designed around the environmental program with the aim to have fixed and clear procedures (decentralised governance). However, as discussed above the rules of interaction changed when Stockholm lost the bid for the Games to Athens and the environmental programme ended up being less prescriptive providing fewer opportunities to impose formal rules and provide clear procedures. The *mechanisms of social interaction* can thus be characterised as decentralised governance with the sub-national government deciding autonomously about collaborations. The city selected the architects and contractors in the private sector to draw up detailed proposal, which were later evaluated by the city (ITDP, 2011).

With regards to the features concerning content, the *goals and targets* then were inspired by national government's ambitions, but were uniform and level specific across in Stockholm. The predominant *policy instruments* in HS were norms and standards, enforced trough covenants and performance contracts, and incentive based instruments such as subsidies. These approaches are exemplary to a mixture of decentralised governance and public-private governance. In terms of *policy integration*, Hammarby Sjöstad is exemplary in its environmental policy integration across social and economic issues. Moreover, the development of HS shows integration of policy aims across sectors of transport, energy, water & waste. Finally, regarding the *policy-science interface,* the development of HS is typical to decentralised governance as the focus is on generic expert knowledge, but leaves room for issue-and-place specific knowledge. Knowledge primarily came from within the City Planning Administration itself, the Royal Institute of Technology and the consultancy firm Grontmij AB. Lay knowledge was not considered in the development of HS.

Overall, the governance approach in Hammarby Sjöstad primarily shows characteristics of decentralised governance with some characteristics of public-private governance. However, the City has imposed and regulated the project from the start.

3.1.3 STIMULATING FACTORS

The above analysis of the planning process of Hammarby Sjöstad, provides an overview of possible stimulating factors in its development.

It seems that much of the success in the case of Hammarby Sjöstad is attributed to the city authority's '**proactive stance**' towards development and the level of ambition to create a low-carbon urban district when the need for housing was there. The many stakeholders were under strict guidance from the City of Stockholm to build according to the city's principles. The level of '**stakeholder interaction**' and the '**integrated planning process**' helped to create a thorough master plan that ensured high standards in both the design quality and the environmental performance of the buildings. The use of a competition between contractors was used by the city authorities to drive up the standards across the project. However, the case of Hammarby Sjöstad shows a somewhat deviating approach to stakeholder interaction from the other case-studies in this research. Essentially through a top-down approach, in which the City of Stockholm led the process and involved mainly powerful infrastructure companies from Stockholm, the Hammarby Model was developed and is broadly acknowledged to be unique and to have been an essential stimulating factor in the success of the project (Vernay, 2012). Here, the planning process engaged producers to create a low-carbon neighbourhood, but did not engage the community.

This central government control was facilitated by the '**political will**' to make HS a success. However, much of the political will came from leading local politicians' interest in hosting the 2004 Summer Olympics. The suggestion of HS as a site for the Olympic Village in the bid for the Games served as a '**window of opportunity**' for its development. The call for an environmental focus in the applications by the Olympic Committee inspired the local leading policymakers to lobby for the development of HS as a sustainable urban district. The resulting '**environmental program**' proved to be "vital to the development process of Hammarby Sjöstad, specifically its drive to create a sustainable urban district" (Iverot & Brandt, 2011, p. 1043).

The city of Stockholm provided considerable '**leadership**' in planning and implementing LCD or sustainable urban development strategies. The above analysis shows that the planning of HS was proactive and, by exerting considerable power over the project and by providing considerable resources to the implementation of the project's plans, the local government was an important stimulating factor in the success of the project. The planning of HS was facilitated by the fact that the city owned most of the land and preferred to pay compensation far above the market price to companies that threatened to appeal against expropriation decisions (Vestbro, 2004).

The '**sympathetic political climate**' for environmental measures, facilitated by the continued presence of green parties in the City Council, has been a further important stimulating factor (Iverot & Brandt, 2011; Kasioumi, 2011). Also, the local population in Stockholm has certain characteristics which, in relation to urban change "have minimized aversion to change and conflicts about distribution of resources among social and environmental goals (Kasioumi, 2011, p. 107)".

Additionally, the project was partially supported by the '**national subsidy program**' (LIP) that encouraged municipalities to become part of an ecologically sustainable society, and has been important in achieving the operational goals of the environmental program (Iverot & Brandt, 2011; Suzuki, et al., 2010).

Furthermore, the '**coordinated & competent project organisation**', facilitated by the Project Team, "was important in achieving the aims and goals of the environmental program" (Iverot & Brandt, 2011, p. 1055). The central role of the interdisciplinary and interdepartmental project management team was key to the outcome of the Hammarby Sjöstad project (Loftus, 2011; Iverot & Brandt, 2011). The Project Team had a considerable stimulating role in the development had several positive effects. First, by being housed in the Development Department, the team had greater access to and control over public funds (Suzuki, et al., 2010, p. 21). Second, it provided for a much stronger position to leverage and negotiate with private parties and their interests. Furthermore, the various departments were integrated in to a single fabric, led by a project manager and environmental officer who were charger to guide and influence public and private stakeholders towards the realization of the environmental objectives of the project (ibid). This approach bundles different disciplines

and types of knowledge and forces them to work effectively towards a joined goal (Freudenthal, 2012). Lastly, the city authority was able to drive up standards across the development through the extensive master plan and through measures such as a competition between the 40 contractors involved in the project (ibid).

The '**integrated planning**' process and '**cooperation**' between stakeholders has been an important stimulating factor. Each of the neighbourhoods in HS have been developed as a cooperative effort between architects, investors and developers. The integrated planning process, led by public agencies, was collaboration-intensive, in the sense that planners focused on creating and improving technical capacity and building alliances (Kasioumi, 2011).

Lastly, by tapping into '**existing/familiar technologies**' in which the country already held a strong position, the project has benefited from the '**presence of an environmentally innovative industry**' and reduced uncertainties in development (ibid).

3.1.4 CONCLUSION

Next to the above mentioned stimulating factors in the development of Hammarby Sjöstad, a number of lessons can be extracted from the analysis. Characterized by a mostly top-down, its less participatory approach, the strong leading role of the government, the quantitative assessment criteria, and the large-scale development of land and implementation of technologies, make that the case of Hammarby Sjöstad deviates from the other EU cases.

While many stakeholders were involved, they were mainly powerful government or private actors. Future residents and NGO's have not been involved in the development process. Rather than relying on behavioural change trough information dissemination or forceful measures such as bans or a penalty to achieve LCD outcomes, HS was been built in such a way that residents are required to live a more environmentally friendly lifestyle. Apparently the outcome of the top-down, technology oriented approach, much of the environmental outcomes of HS are due to the design of buildings, and the design and provisioning of green public transportation. As a result, HS lacked public participation in the planning process and therefore lacks interaction between users and developers. Because future users of the implemented sustainable systems and concepts were not included in the planning process, and information on sustainable living were only disseminated trough brochures and the education centre, residents' behaviour did not reflect the project's ambitions or targets (Loftus, 2011). As put forward by Williams (2012) and Abdalla (2012), planning approaches which do not address the attitudes or lifestyles of those living in low-carbon neighbourhoods, will only partially address the issue of energy consumption as residents' beliefs, needs and expectations towards sustainable technologies have a strong influence on project performance in the use phase. Enabling future residents in the development process might build the necessary awareness and long-term support for sustainability measures in low-carbon urban development.

Moreover, the analysis shows that the effect of the political climate on projects' ambitions should not be underestimated. The development of HS has not been entirely without the messy influence of politics, exemplified by the changes in parking space standards and changes in the level of public versus private-ownership land allocations (Vestbro, 2004; Loftus, 2011).

The case study further shows the importance of setting realistic goals and targets. In a way, the ambitions for Hammarby Sjöstad were a bit too high (Cederquist, 2012). Although there is always a difference between political goals and ambitions, an ambitious goal does drive innovative development, but the ambition should not be unattainable. Moreover, without clear responsibilities and without clear quantifiable goals, the environmental program cannot be evaluated during development or in the use phase. The analysis has shown that the environmental program of HS lacked clear guidelines for the assessment process and lacked a description of the allocation of responsibility related to the performance monitoring of the development (Iverot & Brandt, 2011). For new low-carbon urban districts, the responsibility for the monitoring of environmental goals of the project should be cleary stated in written agreements during the early stages of the project. The institutions responsible for monitoring, should ideally be involved before the overall goals and targets are formulated to ensure their quantifyability and achievability. By doing so, planners make sure that environmental considerations are fully integrated into the urban planning and design.

Future developments can learn from the systems-based technology innovations in Hammarby Sjöstad, much of which can be transferred to other areas of development. Most importantly, however, it is the holistic approach to urban development which should be transferred to other projects. Not so much the technologies itself, but the holistic vision promoted in HS is an important lesson as any urban development should go hand in hand with social, economic and political considerations next to the environmental aspects.

Lastly, the case study shows that sometimes the opportunities for low-carbon urban development are provided through windows of opportunity, such as the Summer Olympics for Hammarby Sjöstad. Future developments should look forward to, and utilize, such critical moments that can provide the incentive needed to realize certain projects.

Case Study

BedZED, United Kingdom

3.2 BEDZED (LONDON, UNITED KINGDOM)

The **Bed**dington **Z**ero fossil **E**nergy **D**evelopment (BedZED) is the largest sustainable mixed-used district in the United Kingdom (UK), combining residential use with commercial purpose (Abdalla, 2012). BedZED is situated in Hackbridge, south London in the London Borough of Sutton and was specifically designed at being a zero (fossil) energy housing community. BedZED aimed to be a carbon neutral development by producing at least as much energy from renewable sources as it consumes (BioRegional Development Group, 1999). The BedZED development was the first of its kind in the UK and inspired for new innovations and standards in sustainable building when it was built in 2002 (Homewood, 2009). The community comprises 82 homes, 18 work/live units and 1,560m^2 of workspace and communal facilities (Dunster, 2009).

BedZED offers an integrated solution to the challenge of sustainable living within the urban environment (Kong, et al., 2002). Environmental, social and economic needs are combined with strategies to reduce energy, water and car use. By mixing living and workspace, commuting is reduced and helps boost the local economy. Moreover, the mix of sale and rent homes at affordable market rates aimed to attract both high and low incomes, to form the basis for a socially inclusive community (ibid). Lastly, with the creative use of a brownfield site and the cradle-to-cradle approach, BedZED aimed to become an example for the design of sustainable residential areas.

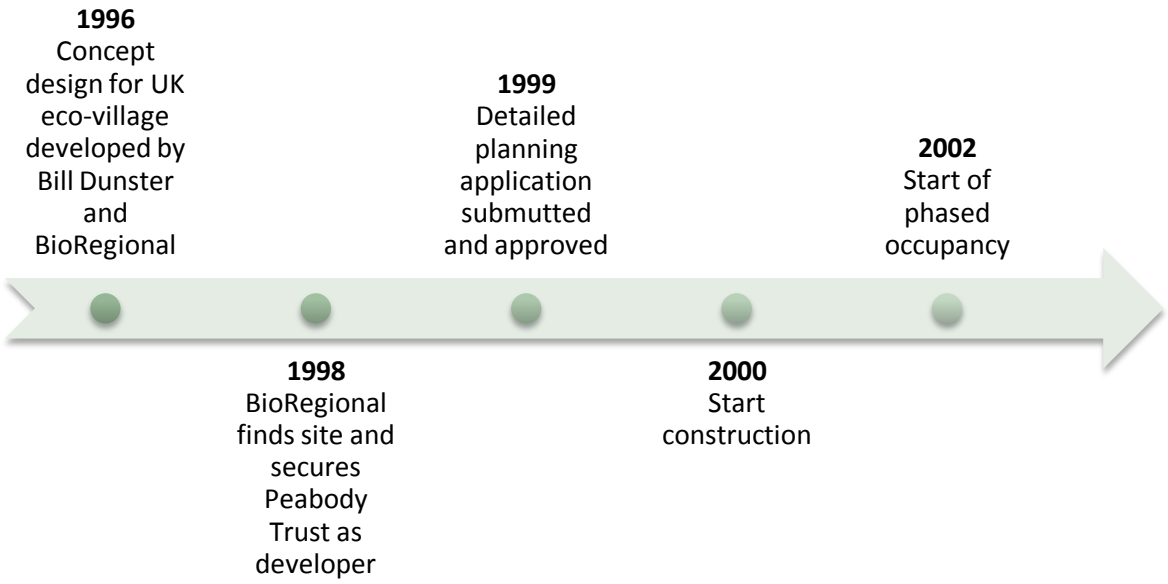


Figure 8: Process overview (Dunster, 2009)

3.2.1 CHARACTERIZATION OF THE PRACTICE IN PLACE

The following chapter will describe the key elements of BedZED. It aims to provide an overview of the LCD strategy by discussing the "*field of activity*", "*government & project ambition*", "*implemented technologies*" and the "results & problems in use".

3.2.1.1 FIELD OF ACTIVITY

The low-carbon development strategy (LCDS) for BedZED remains unusual as it tackled carbon emissions in an integrated manner. The aim was to limit carbon emissions not only in domestic and office energy use, but also by covering the embodied impact of construction (including the emissions arising from the building materials used), personal transport, food and waste (Chance, 2009). Other sustainability issues such as water, quality of life and strengthening the local economy were also covered, making BedZED "one of the most coherent visions of sustainable living in the world" (ibid, p. 529).

Transport

One of BedZED's important characteristics is its approach towards transportation. With The Green Transport Plan (GTP) developers aimed to reduce car use by reducing the need to travel, promoting public transport and by offering alternatives to private car travel (BioRegional, 2009). Examples include reduced car parking spaces, the promotion of electric vehicles by the provisioning of free charging points of 'green' electricity from photovoltaic panels and reduced car parking costs (BioRegional, 2009).

In addition to the GTP, BedZED also includes an on-site car club, cycling facilities and nearby stores to reduce the need to travel by single car. The car club, called "ZEDcars" works together with the UK's leading car-sharing operator, City Car Club. When residents first moved in, information on local transportation information and monthly welcome evenings were established to inform the public.

Waste and Water

Homes are fitted with water-saving appliances[21] and visible meters to reduce the mains water demand. Rainwater is recycled and the Green Water Treatment Plant (GWTP), designed for BedZED, cleans all of the site's wastewater which then can be reused to flush toilets and irrigate gardens (BioRegional, 2009).

Urban Land Use and Spatial Structure

The design of each house at BedZED is design in such a way that all excess heat given off during the day during activities such as cooking, is stored and reused again. Houses are triple glazed, incorporates a minimum of 300mm insulation, thermally massive floors and walls, good daylight, passive-stack ventilation with heath recovery and has energy-efficient lighting (Dunster, 2009). Moreover, homes are arranged in south facing terraces to maximize heat gain from the sun, known as passive solar gain. Each terrace is backed by north facing offices, where minimal solar gain will reduce the tendency to overheat and the need for energy hungry air conditioning (BioRegional Development Group, 1999). Heat from the sun and that generated by occupants and every day activities, combined with wind driven ventilation, generates a comfortable temperature in BedZED homes. The need for space heating, accounting for a significant part in the energy demand in conventional dwellings, is therefore reduced or almost eliminated (ZEDfactory, sd).

Moreover, BedZED set out to source its labour and materials as locally as possible with a target-sourcing radius of 35 miles. The sourcing policy enabled the completed embodied carbon to compare positively with that of a volume house builder's industry standard product, despite BedZED dwellings having thicker walls and a higher thermal mass (ibid). The buildings were constructed using renewable or recycled materials, sourced from sustainable certified forests

[21] Dual flush 2.4 liter flush toilets, reduced flow taps (3 liters/minute) and shower heads (11 liters/minute)

Energy

Electricity demand is addressed by fitting homes with energy efficient appliances, visible meters, good daylight design, passive ventilation and aerated showers.

Energy use at BedZED has been reduced considerably and the remaining demand was designed to be met by a CHP-plant fed by locally produced waste wood (BioRegional, 2009). The local waste CHP and solar PV panels were designed to provide 20% of the electrical demand and would make BedZED a CO_2 positive urban area.

3.2.1.2 GOVERNMENT & PROJECT ABITION

At the national level, the UK government had pledged to move towards low-carbon growth, reducing GHG-emissions and taking advantage of this growing market at the same time. Along with Germany, the UK is often mentioned as a 'climate champion', but even champions struggle to comply with their carbon reduction targets (UN-Habitat, 2011). By 2004, it became clear that the UK's Climate Change Programme of 2000, would not achieve its mitigation targets as expressed in the Kyoto Protocol, because emissions had been growing at 2% annually from 2002 (ibid). A revised programme, Climate Change: The UK Programme 2006, was launched in which a mixed set of regulatory and taxation mechanisms were to support energy-efficient and renewable energy programmes. The programme pledged a reduction of 20% in carbon emissions by 2010.

At present, the United Kingdom has both international (Kyoto Protocol) and domestic (Climate Change Act) targets to reduce emissions. The UK Parliament passed the Climate Change Act in 2008, which sets a legally binding target to reduce greenhouse gas emissions in the UK by at least 80% below 1990 levels in 2050. To drive progress towards this target, the Act introduced a system of carbon budgets (see Figure 9) which set a legally binding limit on the amount of emissions that may be produced in successive five-year periods and holds the UK Government accountable for measures to achieve them (HM Government, 2011a).

The first three budgets were set in law in May 2009. By the end of 2012, emissions are to be reduced by 23%. By 2017, emissions are to be reduced by 29% and by 35% in 2022. The fourth carbon budget was set in law in June 2011 by the Coalition government and set a target of 50% emissions reductions by 2027. Moreover, by 2050 all buildings will need to have an emissions footprint of close to zero.

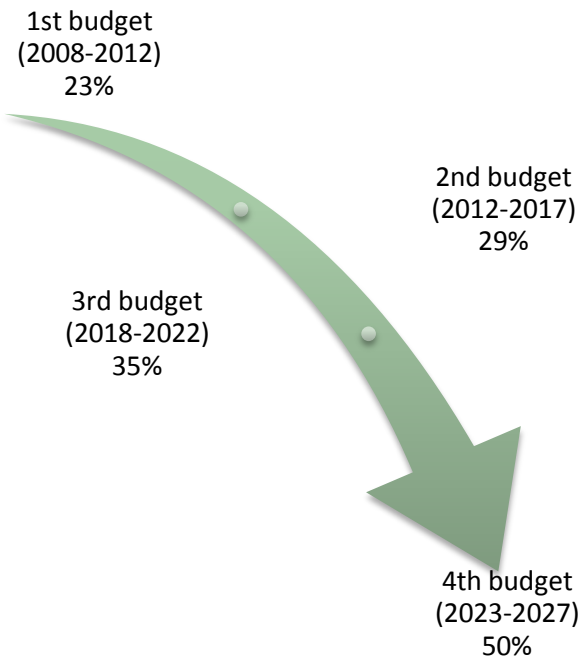


Figure 9: Carbon targets below 1990 levels (adapted from HM Government, 2011)

The original Climate Change Programme, at the time of BedZED's construction, addressed the United Nations Framework Convention on Climate Change (UNFCCC) commitments, which were first adopted by the UK in January 1994. The Programme identified emission reduction measures of 6% below the business as usual baseline and were largely based on voluntary incentives. Fiscal measures were confined to increased road transport fuel tax, the funding of home energy efficiency programmes was far lower than originally proposed and there were few effective measures for the business sector (Eyre, 2001). Nevertheless, without radical climate policies emissions reductions had been achieved.

By 1997, the Labour Government made considerable adjustments in the policies to address its own target of a 20% reduction in CO2 emissions by 2010 and the six-gas basket22 commitment of a 12.5% reduction, as agreed under the Kyoto protocol. The new programme outlined measures that would reduce CO2 emissions by 20% and emissions of the basket gasses by 23% (ibid.).

However, despite the sharp reduction in emissions due to the recession in 2009 but because of the increase in emissions in 2010, driven by increases in emissions from households, power generation and industry, the domestic goal of a 20% reduction in CO2 emissions by 2010 has been decisively missed (Cambridge Econometrics, 2011). According to Cambridge Econometrics, a 16,5% reduction has been achieved and forecasts that the 20% target, on current policies, is not likely to be met until 2020. It appears that the target would have been missed by a greater margin without the financial crisis and the unanticipated impact of lower economic activity on energy use by final users.

The failure of the Coalition's predecessor to achieve the 20% target, illustrates the policy challenge of setting long-term targets and effectively reducing carbon emissions. The majority of greenhouse gas reductions in recent years have been achieved in gases other than carbon dioxide, most notably in curbing the release of methane from landfill sites (ibid).

Table 12: The UK's commitments to international treaties on Climate Change

(International) treaties on Climate Change	Ratified/Signed?	When?
UN Framework Convention on Climate Change (UNFCC)	V	1993 (signed in 1992, went into force by 1994)
Kyoto Protocol	V	2002 (signed in 1998, went into force in 2005)
Agenda 21	V	1992

Progress towards Kyoto target

On average, the emission levels in the UK for the period of 2008–2010 were 24 % lower than the base-year level, and well below the burden-sharing target of -12.5 % for the period 2008–2012 (EEA, 2011). For the sectors not covered by the ETS, emissions were with 12.2% significantly lower than their respective target (ibid). By the end of 2010, the country was therefore on track towards its burden-sharing target. The report, however, critiques that the 2020 domestic GHG-emissions could be lower than its current target.

[22] The basket of greenhouse gases covered by the Kyoto Protocol consists of six gases: carbon dioxide, methane, nitrous oxide, hydro fluorocarbons, per fluorocarbons and sulfur hexafluoride.

At the local level, London is committed to several international treaties (Table 13). London has the ambitions to be the low-carbon capital that leads the way, and makes the most of the global low-carbon economy (HM Government, 2012b). By 2025, the city aims to have reduced its greenhouse gas emissions by 60% (ibid). Through the retrofit of buildings, increased used of electric vehicles, building a decentralised energy network and increased energy production from waste and recycling, the Greater London Authority aims to achieve its target (ibid).

Table 13: London's commitment to (international) treaties (ICLEI, 2012a; European Commission, 2012)

Treaty	Signatory?	When?
ICLEI –Local Governments for Sustainability	V	2006
Covenant of Mayors	V	2009
Aalborg Charter	V	?

Project ambition

With the aim to prove that a high quality of life is possible while living within sustainable lifestyles, the main objective of BedZED was to develop a fossil energy neutral residential district. The main objectives were to use 100% renewable energy, the reduction of energy for heating, cooling and ventilating homes by 90% compared to the average UK home, reduce the amount of potable water use by 50% and the use of photovoltaic panels for the charging of 40 electric vehicles (Abdalla, 2012).

> *"The challenge at BedZED was to show that it is possible to provide a holistic living/working community enjoying a high overall quality of life, while limiting its consumption of scarce national resources (…)" (Dunster, 2009).*

According to BioRegional (2012; 2009), BedZED's original aims were:

- Reduce main water consumption compared to the UK average by 33%
- Reduce hot water consumption compared to the UK average by 33%
- Reduce electricity consumption compared to the UK average by 33%
- Reducing space heating needs compared to the UK average by 90%
- Reduce private fossil fuel car mileage to 50% of UK average
- 60% recycling rate by weight of waste
- Material sourcing policy within 35 miles area

3.2.1.3 IMPLEMENTED TECHNOLOGIES

In order to achieve the above-mentioned ambitions, several sustainable measures have been taken to reduce the environmental impact of the development. Use of passive solar heating, on-site ecological water treatment, wind powered ventilation systems, low embodies energy materials, recycled timber, reuse structural steel, bike facilities and recycling facilities.

The original technical concept of BedZED consisted of the following elements:

- Improved thermal building envelope and passive solar energy gains;
- Heat recover wind cowls and night cooling;
- Woodchips-fired combined heating plant (CHP) for space heating, hot water and electricity;
- Gray Water Treatment Plant (GWTP);
- Photovoltaic panels for feeing electric cars.

3.2.1.4 RESULTS & PROBLEMS IN USE

Ten years after the development of the UK's first carbon-neutral housing development, BedZED is underperforming its carbon targets and is not quite zero-carbon (Homewood, 2009).

At the time of development, BedZED was a forerunner and had very ambitious sustainability objectives (Abdalla, 2012). The objectives to achieve fossil energy neutrality, to attract residents to purchase electric cars and to implement a green water treatment plant at the site were unrealistic (ibid: 56). The CHP system has failed due to technical and financial problems, the Green Water Treatment Plant (GWTP) has been replaced due to high operational costs and some residents have mentioned overheating problems in the summer (ibid). A gas-condensing boiler currently produces hot water and most of the electricity is drawn from the national grid, with a proportion of energy being generated on-site by photovoltaic panels.

Energy

Nevertheless, BedZED households' use 2.579 kWh of electricity per year, according to BioRegional (2012), which is a 45% reduction (3.4 kWh/person/day) compared to the local average. Despite the failure of the CHP plant, BedZED households use 3.526 kWH of heat (from a gas fired district heating system) per year – 77% less than the average in Sutton. BedZED residents use 58% less water (72 litres/person/day), 60% of the waste is recycled and a reduced car mileage by 64%[23] (2.318 km/year). BedZED demonstrates that the 80-90% carbon reductions needed in Europe can be achieved cost effectively, but only if government and business also reduce carbon emissions from services and products (ibid).

BioRegional (2009, p. 9) concluded in a report that the average ecological footprint of a BedZED resident is 4.67 global hectares (equivalent to needing 2.6 planets of resources if everyone in the world lived like this). If BedZED was zero carbon as designed, with the biomass CHP working, the average footprint would be 4.32 global hectares (or 2.4 planets), while the determined resident, who would make significant efforts to reduce their impact, would achieve an ecological footprint of 3 global hectares (1.7 planets).
Even though this is a significant decrease in ecological footprint, it remains an unsustainable form of urban development. The limiting factor seems to be the impact of residents outside the district itself.

However, despite these complications, "the energy efficient design and the output from the solar PV panels mean that BedZED homes have reduced their carbon dioxide emissions by 56% compared to the average UK home" (Chance, 2009, p. 534). If the rest of Europe were to be transformed in the style of BedZED, "we could reduce our carbon dioxide emissions by 90 per cent without sacrificing our quality of life (ibid., p. 529)."

Transport

Due to air travel, which is higher at BedZED than for Sutton as a whole and despite achieving significant reductions in car journeys, there is an overall 13%, increase to 0.75 global hectares at BedZED (BioRegional, 2009). Related to car ownership, the report concluded that it "is likely that tenure is a more important influence on car ownership than any environmental imperative (ibid., p. 26)." Car ownership at BedZED for owner-occupied households is 83%, compared to 47% for social housing, 43% for shared ownership and 0% for privately renting households. Nevertheless, average car ownership[24] is 0.6 vehicles per household, compared to the 1.6 average for Sutton. Interestingly, none of the households surveyed by BioRegional (2009) owned an electric vehicle despite the stimulating measures taken. A reduction in car mileage of 64% (2,318km/year) has been reached as compared to the national average.

[23] Compared to the national average

[24] Average car ownership was the same in 2003 and in 2007

Waste & Water

The aim was to have a kerbside waste and recycling service for BedZED. The London Borough of Sutton, however, could not provide this service (BioRegional, 2009). The research shows that residents recycle 50%, compared to the average of 21% for Sutton.

A reduction of 58% in mains water consumption has been reached with minimal behavioural change and by fitting fairly standard, affordable water-saving fittings in homes. BedZED residents use 72 litres/person/day of mains-water as compared to the local average of 143 litres/person/day for metered homes (ibid). The Green Water Treatment Plant (GWTP) installed at BedZED worked well for rainwater harvesting. However, the operating and maintenance costs could not justify its continued use on a commercial basis. Moreover, the plant proved to use more energy than conventional sewerage and sewage treatment (ibid). Although useful for research purposes, the plant is therefore no longer in use. Introduced by Thames Water and Peabody as a three year research project, the site is now hosting the UK's first membrane bioreactor (MBR) to use recycled water for non-potable domestic use. The MBR now processes wastewater from all buildings on-site since June 2008.

According to Bioregional (2009), on-site water treatment at this scale is currently not cost effective (although results from the MBR may prove otherwise) and is predominantly unsustainable on the grounds of energy consumption.

Urban Land-Use & Spatial Structure

The local sourcing policy enabled 52% of the materials to be sourced from within the target 35-miles radius (Lazarus, 2009). However, on average the sourcing distance was 66.5 miles. The sourcing policy saved 120 tonnes of CO2 emissions, 2% of the scheme's embodied CO2, and was 40 miles less than the national average hauling distance (ibid).

In total, 15% of the total materials were reclaimed and recycled materials, reducing BedZED's embodied CO2 by 4% (ibid). Due to complex supply chains and a requirement for too much staff time, not all materials could be reclaimed or recycled (see Table 14).

Table 14: Reclaimed & Recycled materials (adapted from Lazarus 2009)

Material	Achieved on BedZED	Easy
Reclaimed steel	✓	Fairly Easy
Reclaimed timber for internal studwork	✓	Fairly Easy
Reclaimed timber for external studwork	X (small quantity)	Difficult
Reclaimed floorboards	✓	Easy
Reclaimed bollards	✓	Easy
Recycled aggregate	✓	Fairly Easy
Recycled crushed green glass sand	✓	Easy
Reclaimed doors	X	Difficult
Reclaimed paving slabs	X	Difficult
Reclaimed shuttering ply	✓	Easy
Re-used sub-grade fill	✓	Easy

3.2.2 DEVELOPMENT PROCESS AND GOVERNANCE

In the paragraphs below, the main characteristics of the planning process and governance approach will be discussed.

3.2.2.1 DEVELOPMENT PROCESS

Control of the planning process: main actors, roles & responsibilities

The configuration of initiating actors in the development of BedZED consists of a joint initiative between Bill Dunster Architects and environmental consultancy group BioRegional. The idea of BedZED was hatched by Bill Dunster who proposed a dense, mixed-use zero-energy approach after his prototype, Hope House, while BioRegional was keen to apply their ideas on ecology in sustainable lifestyles (Chance, 2009). The Peabody Trust funded the entire construction from start to finish and is responsible for the community maintenance and infrastructure (Dunster, 2009). The proposal for acquiring the public space of land was made by the Peabody Trust. Bill Dunster was the project manager who took day-to-day decisions, provided leadership and reported back to the project team. Responsibilities of key decision-makers were clearly defined (Abdalla, 2012).

The UK government has not been a key player within any of the project teams in BedZED. In fact, much of the low-energy housing built in the UK has not explicitly been driven by government policy or national regulations, but rather involving an entrepreneurial individual (Lovell, 2007). As much as the case with BedZED, low-energy housing projects were thus typically developed as one-off experimental projects.

The government, however, was not entirely without influence. The UK government did contribute

grant funding and the local government, the Sutton Borough Local Council, has been supportive with its strong environmental policy and in the sale of the building land (ibid). The bid incorporated "letters of support, a scheme description that quantified the long-term environmental, economic and social benefits, and a summary of how ZED would be a mechanism for the Council to deliver objectives under its environmental and planning policies" (BRESCU, 2002, p. 6). The proposal was judged by the local authorities and the land was granted for the development of BedZED despite it not bidding the highest price was given precedence because of its extra environmental and social benefits to the environment (BRESCU, 2002).

The UK governments' reactive approach to BedZED and LCD urban development might be explained by the fact that its policy-making capacity has been significantly reduced through privatisation and liberalisation of the energy and housing markets since the 1980s (Lovell, 2007). Increasingly lacking the resources and political power to implement sector-wide policies to achieve radical change, niches such as BedZED possibly become an increasingly important element of policy-making in response to issues such as climate change and the low carbon transition.

Vision, goals & means

The project failed to formulate realistic goals using the technologies available at that time (Abdalla, 2012). Moreover, the material sourcing policy goal affected the quality delivered by contractors. Especially, low-environmental impact materials were difficult to find in this restricted area. Local material sourcing could thus not be guaranteed (ibid).

BioRegional secured funding from the World Wide Fund for Nature International to promote the ZED scheme, identify a potential site and secure a development partner (BRESCU, 2002). Moreover, the "London Borough of Sutton had a crucial role in the project" as sustainability goals were valued over economic gains (Abdalla, 2012, p. 126). An adequate budget for the development was provided by Peabody and all essential resources were provided (ibid: 42).

Performance monitoring

BedZED had a clear system for performance monitoring and feedback. Performance and progress delivered by the subcontractors as well as budget overrun was monitored on a regular basis and fed back to the project team (Abdalla, 2012)

Transformations

Construction was undertaken by Ellis & Moore Consulting Engineers as the main contractor. Subcontractors were chosen for their quality but were also required to be local. Abdalla (2012) reported that sub-contractors did not cooperate as expected leading to some conflict in the realisation phase.

Participation & Communication

According to Chance (2009, p. 531), "BioRegional and Bill Dunster Architects undertook extensive consultation on the plans with the local community, supported by a vocal local church" (Chance, 2009, p. 531). BioRegional consulted local stakeholders in order to assess grassroots support for the Zero Energy Development (ZED) scheme on the site and two exhibitions were held for local people (BRESCU, 2002). However, a recent study by Abdalla (2012) concludes that BedZED failed to consider the effect and views of end-users, as residents were not fully involved in the project design. The project therefore failed to manage uncertainty in predicting residents' behavior in using the heating system and purchasing electric cars.

A clear communication plan was maintained between the project manager and involved parties. The continued presence of the project manager on-site facilitated daily communications (Abdalla, 2012).

Environment

The site manager failed to influence Peabody enough to stop the replacement of the woodchips-fired CHP system with natural-gas fired boilers (ibid).

Continuity

Bill Dunster functioned as a "project champion" by providing day-to-day on-site guidance and converted his ideas into a sustainable residential district (ibid).

In order to overcome uncertainty, Peabody required advanced detailed design work in order to prove the cost viability of the project and to put in a competitive bid for the site. However, despite the provisioning of an adequate budget and several funds, BedZED could not display continuity as additional funding for a new sustainable CHP system could not be found (Abdalla, 2012).

3.2.2.2 GOVERNANCE ANALYSIS: ROLE OF THE GOVERNMENT

Characteristic for self-governance, *the initiating actors* for the development of BedZED primarily lies with private sector organisations. Consisting of a joint initiative between a private architecture firm and an environmental consultancy group, the initiative for a low-carbon neighbourhood started in the private sector. The UK local government has not been a key player within any of the project teams in BedZED. In fact, much of the low-energy housing built in the UK has not explicitly been driven by government policy or national regulations, but rather involving an entrepreneurial individual (Lovell, 2007). The *stakeholder position* as can be found in the development of BedZED can therefore been seen as self-organising, self-governing entities who determine the involvement of other stakeholders. The ideas for BedZED were first conceptualised by Bill Dunster Architects who then sought the involvement of the external environmental consultancy group. The predominant *policy level* at which key actors operate was therefore the local level for BedZED. However, the project was not entirely without governmental influence. At the national level, the UK government did contribute grant funding and at the local level, the Sutton Borough Local Council, has been supportive with its strong environmental policy and in the sale of the building land. This is exemplary to the characteristics of self-governance. In terms of the formal *basis of power* of the key actors involved, actors had considerable autonomy. Regarding institutional features, the *model of representation* can be characterised as a partnership under self-governance or interactive governance as the partnership primarily consisted of a private-private partnership but shows features of participatory public-private partnerships as well. This process allowed for the *rules of interaction* to be a mixture of formal and informal exchanges rules. Overall, the *mechanism of social interaction* can thus be characterised as bottom-up in which negotiations and deliberations were central to the planning process. Concerning the policy content, the overall goal of developing BedZED was driven by the ambition of sustainable development coming from private actors. *Goals and targets* were specific to the development of BedZED. The predominant policy instruments to achieve these goals and targets are typical of decentralised and public-private governance with incentive based instruments and a facilitative role in securing the land for developing, at reduced rates. Finally, regarding the policy-science interface, the development of BedZED is typical to the interactive governance approach in which transdisciplinary knowledge, coming from expert and NGO-organisation, was used to integrate the different policy aims for the local context of BedZED.

Concluding, the governance approach taken in BedZED shows characteristics of decentralized governance, with a focus on public-private governance and interactive governance.

3.2.3 STIMULATING FACTORS

In the case of BedZED, some unique circumstances and several stimulating factors, originating from both the private as well as the public sphere, facilitated its creation. Because it was just a new idea and because of conflicting ideas about green design itself, the project faced initial adversities (Chance, 2009). A mixture of several strands of activity coming together assisted in overcoming these initial adversities.

Near the turn of the century, green or low-carbon housing was still a rarity in the UK, despite the '**large amount of publicity**' around certain high profile developments such as BedZED. Just before the development of BedZED, '**climate change a policy issue**' entered the discourse in the UK during the 1990s. The discourse shifted from sustainable housing to low-carbon housing development and prioritized the energy properties of sustainable homes (Lovell, 2007). BedZED became part of the national discourse on low-energy housing in which it was used as existing proof that solutions to climate change were possible. The government, however, considered itself as the main actor involved, despite niches such as BedZED emerging largely in absence of national government support (ibid). Rather the local government where BedZED is situated played a role in the initial stages of the development. '**Local government support**', however, through its strong environmental orientation gave the sustainability benefits of BedZED precedence over financial motivations and sold the building land at a lower market price to the BedZED team (BRESCU, 2002). This, however, did require the approval of the central government because prior to this, the local authority's obligations to sell public land for the best value, was assumed to mean the best price.

The project was led by a determined individual whose vision and prior work on zero-fossil energy housing coincided well with the developing debate on sustainable housing in the UK. Also referred to as a "**project champion**" (Abdalla, 2012), the architect converted his ideas into a sustainable residential district by providing '**leadership**' and day-to-day on-site guidance. Moreover, much of the design ideas for BedZED began five years before any potential client, site, design fees, or development capital was available (Dunster, 2009).

The '**formation of a partnership**' between an innovative environmental advocacy and a solutions-based organisation committed to bioregional ideas for local sustainability – BioRegional – was crucial in recognising the project's potential. BioRegional was specialised in the creation of sustainable environments using local resources. Together they were able to combine the necessary knowledge and motivation to build differently (see for Lazarus 2009 for an overview of the building approach and material policies used) and train contractors for the designs that were developed (BRESCU, 2002; Lazarus, 2009). As a funding partner of BioRegional, the WWF-International played an important role in the initial stages of the development as they provided the '**technical advice and lobbying support**' in securing the site for development" (Kong, et al., 2002, p. 113).

The partnership was aided by a client, the Peabody Trust, who was willing to consider additional values, who was interested in sustainability issues and who was concerned for the life-cycle opereation of its buildings (BRESCU, 2002; Dunster, 2009). A combination of these circumstances provides for the development of new ideas and implementation of innovative technological practices.

3.2.4 CONCLUSION

The case of BedZED shows that the implementation of innovative approaches to counteract mainstream developments requires a powerful partnership between the government, determined individuals and knowledgeable organisations. However, most of the existing sustainable housing niches in the UK, like BedZED, have been initiated and developed by non-governmental actors (Lovell, 2007). The local government was reactive and supportive for the development of BedZED, but it did not play a proactive role in its development. It shows that, without the active engagement of market and civil society actors, in situations of low governmental support or ambition, the transition towards a low-carbon urban environment might be difficult to achieve.

The project showed that the technology and motivation for low-carbon urban districts is available. By doing so, niche projects such as BedZED spur the development of low-carbon development and inform politics about the possibilities. Herein, BedZED became part of the wider sustainability discourse and was influential in the genesis of the UK government policy that all new homes must be zero carbon by 2016 (BRESCU, 2002).

The work of BioRegional (2009) Abdalla (2012) further shows the residents' role in project success. In order for low-carbon urban districts to be truly sustainable, residents' interaction and active participation in sustainable behaviour is crucial to the overall success and outcomes of the project. In relation to the project itself, Abdalla (2012) concluded in her research that BedZED had effective planning, monitoring control, and feedback systems and that clear lines of communication were established. The project, however, failed to take sufficient account of the used technologies and past experience. Moreover, the project budget was overrun and failed to adapt new proven technologies instead of the CHP system.

Main problems are related to three points:

- Implementing non-proven technologies to achieve overambitious project goals
- Failure to form teams that properly cooperate with each other (local sourcing policy)
- Failure to influence the project organisation and the residents to adopt some needed changes

Although BedZED failed in some areas, innovation niches such as BedZED, shape the discourse of low-carbon urban development and provide a learning base for future LCD projects. Nevertheless, BedZED was able to significantly reduce energy and water consumption, making BedZED one of the best practice projects in Europe.

The BedZED-case further shows that the opportunities for local environmental sustainability are there when the local authority supports the development of such innovative projects. However, it should be noted here that BedZED did receive local authority support but it has not been unequivocal and has only been the result of substantial negations efforts.

Case Study

GWL-Terrein, the Netherlands

3.3 GWL-TERREIN (AMSTERDAM, THE NETHERLANDS)

The GWL-Terrain is situated the Westerpark district of Amsterdam city. The brown-field residential development comprises six-hectares of land which was formerly used by the municipal water utility, Gemeente Waterleidingen (GWL). The project was built between 1995-1998 and "nominated as a national demonstration project for energy efficient and sustainable building" (Femenías, 2004, p. 126). The project was one of the first initiatives to build an attractive, socially diverse residential area with environmental values in Amsterdam.

One of the most challenging tasks of the urban designers[25] was to convince developers about the feasibility and market potential of the car-free and ecological neighbourhood concept. Despite all arguments against a car-free neighbourhood, the plan proved to be one of the key successes in the sustainability outcome of the GWL-Terrain (Christiaanse & Salewski , 2009). The concept of sustainability was not widespread when the GWL-terrain (further referred to as 'GWL') was planned. Therefore, the aim of the urban design was not sustainability as such, but a 'good urban design'. Nevertheless, the project has attracted considerable international attention, is often referred to as the first of its kind and as a best practice case for sustainable urban design (Femenías, 2004; Christiaanse & Salewski , 2009).

Although residents had to give up their car to inhabit the new residential area, the apartments sold within hours and, 20 years later, the residents are amongst Amsterdam's most happy residents. The project consists of 600 residences, of which 45% were designated rental homes and 55% privately owned (Femenías, 2004). Moreover, the project includes 1200m^2 of office-space, including a restaurant and shops.

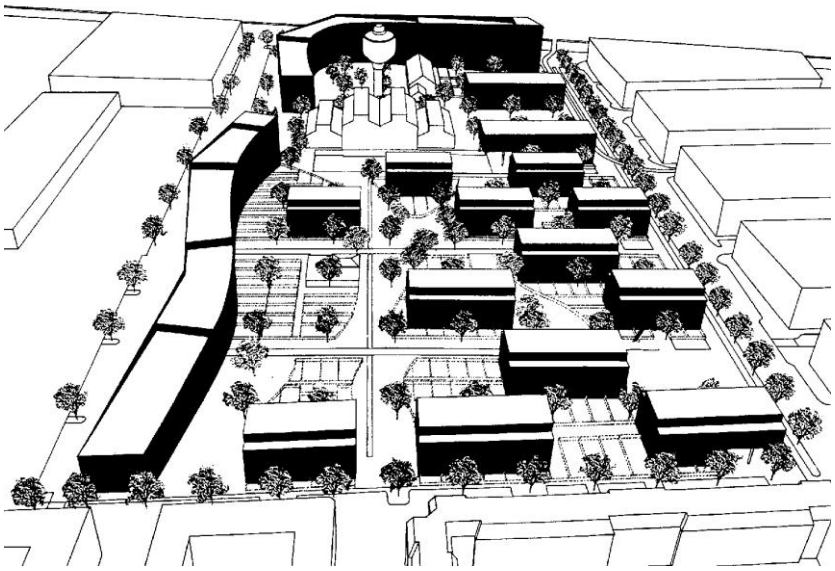


Figure 10: Overview of GWL[26]

[25] Kees Christiaanse Architects and Planners (now KCAP)

[26] Source: http://www.kcap.eu/en/projects/v/gwl_terrein/

3.3.1 CHARACTERIZATION OF THE PRACTICE IN PLACE

The following chapter will describe the key elements of the GWL-terrain. It aims to provide an overview of the LCD strategy by discussing the "*field of activity*", "*government & project ambition*", "*implemented technologies*", and the "results & problems in use".

3.3.1.1 FIELD OF ACTIVITY

The low-carbon development strategy for the development of the GWL-terrain has a broad focus. However, five environmental themes were the focus of developments in the district: traffic, building materials, energy, water, vegetation and waste (GWL-Terrein, 2010). A so-called DCBA list from BOOM environmental advisory bureau was used as a guiding tool in developing the plan for the district.

Transport

The most striking feature of GWL in terms of its contribution to carbon reduction in urban development, is that the district is virtually car-free and has a low parking ratio. Nearby car-sharing reduce the need to own a private car. The district is well connected to the local public transportation system and the urban cycle paths of Amsterdam (TU Delft, 2011). At walking distance, the adjacent district (Staatsliedenbuurt) provides most of the facilities for the residents.

When moving in to the GWL, tenants had to sign a contract that renounced their right to a parking place and the existing 120 parking spaces at the border of the district were distributed by lottery (Femenías, 2004).

Waste and Water

Further measures include *water management* (with a focus on rainwater retention and reuse with rainwater-flushed toilet systems in the three-level blocks) and *waste management* through the separation of waste into four fractions and the collection in underground containers (Femenías, 2004). Rainwater is collected through water collection systems on the apartment roofs and taken via rain pipes to reservoirs beside the dwellings. From these reservoirs, water is pumped into water-saving toilets and is augmented with drinking water if necessary (GWL-Terrein, 2010).

Urban Land Use and Spatial Structure

At the time of designing the new residential district, the choice was made to build alongside the principles of 'green building' (see Figure 11). In the choice of building materials, the project made use of the environmental preference list provided by the City of Amsterdam in 1993 (GWL-Terrein, 2010). The list summarizes all building materials per section from most environmentally friendly to the least. If budgets allowed it, the most environmentally friendly solution was chosen.

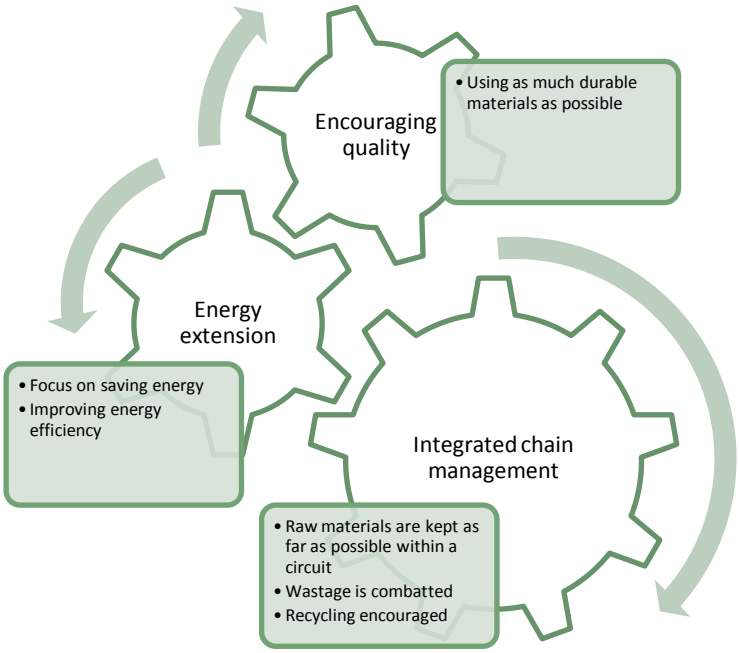


Figure 11: Green Building Principles (GWL-Terrein, 2010)

The area has a green character in which planting has a multifunctional purpose of separating private and collective areas. With 100 homes per hectare the GWL-terrain is a very *compact residential area* (TU Delft, 2011). Sustainability measures at the building level include; *reduced energy use* (through increased insulation, energy efficient windows, passive solar use and district heating with a heat and power generator), *green roofs* (on high-rise buildings) and *sustainable construction materials* (based on the environmental preference lists provided by the city of Amsterdam. The waste generated by demolitions was reused for new constructions and timber from non-sustainable origin was banned (ibid). Around 50% of the area is allocated for flats in social housing, 25% is subsidised owner-occupied and another 25% are on the free-market.

Energy

In the development of the GWL-terrain, dwellings were built to save energy and improve energy efficiency. Although there is no active energy production from wind or sun, the district aims to reduce energy consumption trough insulation, passive solar energy and the use of a CHP-system.

3.3.1.2 GOVERNMENT & PROJECT AMBITION

National

When the ideas for GWL were developed, sustainable development was not as crystallized and popularized as it is today. However, energy saving and efficiency has been an important issue in the Netherlands for several decades. Since the late 1980s, however, the attention shifted to the effects on the environment and more specifically to the reduction of greenhouse gas emissions. The Dutch sustainable building policy began in the early 1990s and several Action Plans have accelerated the application of sustainable building in the Netherlands (Femenías, 2004).

With the issues raised by the Brundtland Report fresh in mind, a first National Environmental Policy Plan (NMP1) was published in 1989 (ibid). One year later, the plan was updated to NMP+ and included policies for the building sector[27]. In the years thereafter, several more NMPs were published to further crystallise sustainability and development. Most notably, however, for the definition of sustainable building was the introduction of the National Sustainable Building Package in 1996. This National Package consisted of voluntary measures for sustainable building. Under this package 'sustainable building' was conceptualised around energy conservation, the reduction of material flows, use of environmental friendly building materials, and the reduction of water consumption. Several other activities within the field of sustainable building have been part of a larger governmental investment plan in environmental management. Fiscal instruments such as 'groen beleggen', 'green mortgages, 'low-interest financing' through the green fund have been available (ibid). These activities aimed to adopt environmental measures on a broad scale, rather than gaining a high level of sustainability in a few projects. Moreover, a national demonstration project programme for energy efficient and sustainable building was instigated between 1996 and 1998.

Inspired by the Kyoto Protocol and the reduction of CO_2 levels, the European Union introduced the 'Directive on energy performance of buildings' (EPBD) for energy efficiency of buildings around 2003. Dutch building regulation, however, has a minimum requirement for the energy performance of new buildings since 1995, in the form of the Energy Performance Coefficient (EPC). A lower EPC-value reflects a more energy efficient building. The ECP-value was initially set to 1.4 and lowered in 2000 to 1.0. The EPC-limit has been lowered 0.8 in 2006 and recently has been set to 0.6 in 2011 (Rijksoverheid, 2012a).

As a EU Member State, the Netherlands starting point for policy development on climate change are the EU regulations (Rijksoverheid, 2012b). The Netherlands has a binding national target to reduce emissions in sector outside the Emission Trading System (ETS) by 16% in 2020 and 21% for sectors that fall under the ETS. The EEA (2011) reports that total emissions remained relatively stable, with current levels being slightly lower that the base-year of 1990. An increase of 13% in, mostly CO_2, emissions from the energy sector has been observed in energy industries and road transport, but was offset by emission reductions in manufacturing and construction industries. On average, emissions in the Netherlands between 2008-2010 were 3.9% lower than the base-year. At national level, projections show the Netherlands could achieve its individual 2020 target in the sectors not covered by the EU-ETS with the current set of domestic policies and measures (EEA, 2011). The report, however, critiques that the 2020 domestic GHG-emissions could be lower than the current target. Moreover, when the Netherlands decided to sign the Kyoto Protocol, the Dutch government decided to meet its obligations by realizing half of the required CO_2 reduction trough domestic emissions mitigation activities, and the other half by trough foreign emission allowances under the Emission Trading Scheme (ETS). By the end of 2010, the Netherlands was on track towards achieving its Kyoto commitments. However, the report critiques that this progress was not only achieved by domestic emission mitigation activities, but trough carbon sinks and planned use of flexible mechanisms[28] as well (EEA, 2011). Earlier this year, however, the State Secretary indicated that the 20% reduction target for 2020 will be realized within the Netherlands itself, without the

[27] Crystallised in the appendix 'Nota Duurzaam Bouwen'.

[28] Either buying or selling tradable 'Kyoto units' or 'Carbon Credits'

purchase of foreign emissions savings (Rijksoverheid, 2011).

Unfortunately, the large national investment programmes in sustainable building made available by the Dutch government at the end of the 1990s, have not been continued into the present century (Femenías, 2004). Changes in the Dutch political climate, greatly affect sustainable development policies and incentives. The Clean and Efficient program of 2007, for example, which had the ambition to reduce GHG-emissions with 30% in 2020, and to increase the renewable energies share from 3% to 20% by 2020, was abandoned in 2010 as a result of shifting political priorities (ECN, 2011). As the Dutch government is highly fluxional, government support for sustainable building is highly depended on the politicians in charge. To date, the policy arena is characterised by voluntary agreements and covenants, with some regulations penetrating the building industry. Because the Dutch financial support system has a notorious complexity and unstable character, "changes in fiscal arrangements and subsidy regimes led to disturbance and delay in project realization (…) (Agterbosch, et al., 2007, p. 1037)." These characteristic make the Dutch situation for entrepreneurial activity and innovation in the field of sustainable development and energy production, unstable and unfertile.

However, the Dutch government showed its commitment to a number of international treaties on Climate Change (Table 15).

Table 15: The Dutch commitments to international treaties on Climate Change

(International) treaties on Climate Change	Ratified/Signed?	When?
UN Framework Convention on Climate Change (UNFCC)	V	1993 (signed in 1992, went into force by 1994)
Kyoto Protocol	V	2002 (signed in 1998, went into force in 2005)
Agenda 21	V	1992

Local

To date, the city of Amsterdam has a focus on CO2 emission reduction and the creation of a liveable city through the fostering of cohesion amongst the various sustainability themes. In the Programme Agreement 2010–2014, the coalition agreement which sets out the City Executive's policies for the coming term, the ambitions are described as follows:

> *In 2014 the city will be sustainable. The quality of the public space will continue to be of a high standard. We can do more with less energy, thanks to new technologies and home insulation. The attention devoted to climate, energy and air quality will have resulted in effective projects, such as electrically powered vehicles, thermal storage, innovative processing of waste and wind energy – projects that are not merely positive for the environment but financially beneficial as well.*

More specifically, the City Council's objective is to reduce CO2 emissions by 40% by 2025, compared to the 1990 baseline (Amsterdam, 2011). The reduction is envisioned to be achieved by:

- Energy savings in existing buildings;
- Climate-neutral new-build (from 2015, all new construction in the city must be climate-neutral);
- Sustainable electricity (200 MW wind energy by 2025);
- Sustainable heating and cooling (thermal storage);
- Electric transport.

Table 16 provides an overview of the treaties Amsterdam is involved in. With regards to ICLEI, Amsterdam is also heavily involved in ICLEI's Local Action for Biodiversity (LAB) initiative, is a member of ICLEI's European Cities for Climate Protection (CCP) campaign, and is involved in the Sustainable Construction and Innovation through Procurement (SCI) Network.

Table 16: Amsterdam's commitments to (international) treaties (ICLEI, 2012b)

Treaty	Signatory?	When?
ICLEI –Local Governments for Sustainability	V	2008
Covenant of Mayors	V	2009
Aalborg Charter	V	?

Project

The GWL–terrain was one of the first projects in the Netherlands with the ambition to combine environmental and architectural values and a car-free area in the central parts of a major city (ITDP, 2011). In order to cope with the housing shortage in Amsterdam, the GWL-terrain was supposed to be a sustainable urban quarter, with green spaces, high-density building and a car-free character (van Lierop, 2012). Mostly being developed for a specific target group, families with children, the development was to be car-free (0.2 cars/apartment), which today represents the unique character of the district (ITDP, 2011). The aim was therefore to develop the former industrial area into a vibrant and sustainable residential area. However, during the time of development (1980s-1990s), the ideas of sustainable urban development were not as crystallised as they are now (Svane, 2008). The project has little quantitative targets, but the so-called DCBA score list from the external environmental advisory bureau was used as a guiding tool. The ambition was to realise the highest possible score (A) throughout the project (GWL-Terrein, 2010). However, Femenías (2004) states that ambitions for GWL–terrain were found in the B- and C- levels.

Some objectives of the project are included in Table 17 below.

Table 17: Project ambitions (Femenías, 2004)

Theme	Ambition
Energy	Combined heat and power (CHP) / Max. 1100 consumption per year
Heating	750m^3 natural gas
Waste water	Limited evacuation; green roofs and rain water barrels
Drinking water	30L per person a day, and reuse of rainwater
Occupant conduct	Direct involvement
Renewable energies	Possible use of passive solar energy
Transportation	Car-free area
	Parking at entrance of living area, norm 0.25
Construction materials	As sustainable as possible

Unfortunately, no further quantitative values have been possible to obtain. Femenías (2004) however, discusses the energy use for space heating for Block 5 in the area. The ambition was set to 60-100kWh/m^2/year, being a reduction of 42-65% compared with contemporary energy use for space heating around 1993. Another comparison can be made on the level of EPCs. The lowest EPC target value for GWL-terrain was 1.10 for all blocks.

3.3.1.3 IMPLEMENTED TECHNOLOGIES

The technologies used in the development of the GWL-terrain weren't necessarily 'top of the bill', but the innovative concept of the new district was primarily the integrated character of sustainability and the car-free design (van Lierop, 2012). Energy reductions and efficiency were realised by implementing:

- Heavy insulation
- Use of passive solar energy
- CHP-plant
- Hot fill washing machines & dishwashers have been used on trial in some houses

Despite the fact that the project did not include the best available technologies at that time, the application of CHP was quite innovative as there was little experience with the use of CHP systems in residential accommodation (GWL-Terrein, 2010). The CHP-plant uses residential heat from generating electricity and uses it to provide the districts' homes with hot water. This system should save almost 50% on carbon-dioxide emissions and the yield is about 10% higher than a normal power station (ibid). The CHP-plant is operated by the local energy company 'NUON'.

3.3.1.4 RESULTS & PROBLEMS IN USE

The GWL-terrain has had considerable national as well as international attention. Unfortunately, not many evaluations are available regarding the fulfilment of the measures for sustainable building. An evaluation conducted by NIBE in 2001, looked at water, energy, materials, waste and urban planning (GWL-Terrein, 2010). The research is most positive about the water-saving taps and showers, the isolation, the use of passive solar energy, and recycling of raw materials in the pavement and on the roof (ibid). The evaluation is downright critical of the environmental impact of the rainwater utilization system in combination with the Gustavsberg water efficient toilet. The CHP-plant, moreover, is criticized because of the long distance between the heat exchanger and tap into the homes, decreasing its overall efficiency. In addition it appears that the environmental benefits of preheated washing water is low, while the costs of such facilities and the purchase of such systems are high. Overall, the research concludes that, in the design of the area, too much attention has been paid to costly and little effective sustainability measures in the water sector, and resulted in relatively inexpensive missed opportunities to energy savings (ibid).

Energy

According to Femenías (2004), a theoretical value for space heating at GWL-terrain has been calculated to be 89 kWh/m^2/year, being a reduction of 48% compared to the 1993 Dutch average, but it remains to be proven if these ambitions have indeed been fulfilled. Another comparison for the ambitions of energy reduction can be made by looking at the ECP-value. The calculated EPC for Block 5 (the lowest calculated value for all blocks at GWL-terrain) was 1.10. During the design and implementation phase of the project, this was indeed lower than the national target of 1.4. However, the national EPC target had been lowered to 1.0 in 2000, rendering the energy performance at the GWL-terrain outdated less than three years after completion.

According to Femenías (2004), the decision to invest in a CHP-system hindered the use of renewable energy sources, such as active solar energy. Moreover, a lower level of insulation could have been used, and still meet the ECP-level norms, because the CHP is more efficient than conventional systems.

Transport

The biggest achievement for the development of the GWL-terrain is that the district is virtually car-free, which adds to the overall liveability of the area and provides a safe area for pedestrians and bicyclists. The heart of the development is car-free and the original residents were asked to sign a non-obligatory statement of support for the car-free nature of the site. To date, none of the 600 residences include a parking space, but several parking spaces were later constructed along the edge of the development, yet a limited number of parking permits remain available for residents (ITDP, 2011). With 80% of the trips made by bike or by walking, non-motorized mode share in the development is much higher than the surrounding area (44% for Amsterdam) and car use is much lower than the average for Amsterdam. Furthermore, the number of bikes owned per thousand residents is 1.300 at the GWL-terrain whilst 730 for the whole of Amsterdam (ibid).

Waste & Water

Throughout the district, special water-saving toilets have been installed. These toilets use 3.5 to 4 litres of water instead of the conventional 6 litres. Special flow enhancers were fitted to the interior sewers to collect 18 litres of waste-water (GWL-Terrein, 2010). Rainwater is taken from the roof via rain pipes and filters to reservoirs beside the dwellings. From these reservoirs, the water is pumped into the toilets. This is augmented with drinking water when necessary.

With hindsight, this system is one of the less successful environmental experiments (Femenías, 2004). The system requires a lot of maintenance as it is vulnerable to obstructions, and uses relatively large amounts of energy to pump the rainwater to the toilets. The system is no longer in use in several blocks of the development. Moreover, water bills are paid in full, decreasing the effect of the cost-cutting incentive for users (ibid).

Urban Land-Use & Spatial Structure

The GWL-terrain is about three times as dense as Amsterdam West, and more than five times compared to the city of Amsterdam (ITDP, 2011). It is denser than what is required for Vinex locations, requiring at least 30 homes per hectare, whilst the GWL-terrain has 100 homes per hectare (ibid). This high-density urban structure enables more efficient use of resources, which can help to reduce carbon emissions.

Moreover, sustainable building materials have been used throughout the development. Examples include the choice of brick facings, which is more expensive but also more durable than other materials, instead of plastic insulation (GWL-Terrein, 2010). Moreover, 20% granulated concrete rubble from the demolition of the former constructions, has been used in the dwellings. Other examples included the use of pinewood, instead of tropical hardwood, aluminium or plastic frames, treated with water-based paints, and for the roofing the more environmentally friendly 'EPDM' was used instead of bitumen (ibid).

Apart from these sustainability aspects, the district has been exceptionally successful in the creation of a liveable area and the creation of social cohesion (van Lierop, 2012). The residents of the district are exceptionally engaged and active in the neighbourhood. The creation of a liveable residential area is further emphasised by the fact that 62% of residents have lived in the development for more than eight years (ITDP, 2011).

Much of the above problems seem to relate to the building design being realised under great time-pressure, which was shortened by one year, and consequently omitted the phase of definite design (Femenías, 2004). According to Femenías, this reduced preparation time led to problems in later phases and the start of construction before all designs were finished. The reason for shortening the time for the building design was that 1994 was the last year that subsidies were available for social housing (ibid). Due to this time limit, less cooperation was possible between architects and the external environmental consultant during the building design phase, reducing the consultants' contribution to checking the design that was already completed (ibid).

Moreover, although the ambition was to realise the highest possible score (A) on the DCBA scheme of the external environmental consultant, the reality in practice was that the average score was slightly lower, around B (GWL-Terrein, 2010). Although the project distinguishes itself with the car-free concept, a high

density and green function for the entire residential district, the setting of a wide variety of ambitions has resulted in no single high-points (van Hall, 2000).

3.3.2 DEVELOPMENT PROCESS AND GOVERNANCE

In the paragraphs below, the main characteristics of the planning process and governance approach will be discussed.

3.3.2.1 DEVELOPMENT PROCESS

Control of the planning process: main actors, roles & responsibilities

The process behind the development of GWL-terrain is long and has involved a variety of different actors, ranging from experts to local inhabitants participating in the process. Although GWL was built between 1995 and 1997, the process of development was initiated in the late 1908s as a "vision of a 'green' living area on the local municipal level and by people who lived in the neighbourhood (Femenías, 2004, p. 126)". It was when the water company decided to relocate around the end of the 1980s that the question for redevelopment of the area arose. Under pressure of housing shortage and a strong lobby of Westerpark District residents, the Amsterdam City Council decided to zone the area for housing in 1989 (ITDP, 2011).

The concept of a 'green' residential district was first suggested by a City Councillor, member of the green party 'GroenLinks' (van Lierop, 2012). The idea was soon adopted by the young and ambitious newly formed District Council[29], consisting of PvDA and GroenLinks, which was responsible for further development of the area (ibid). When local citizens heard of the plan, and the council started to 'recruit' citizens for the development process, the intensive process of developing ideas was initiated (see Figure 12). Local citizens were very assertive and verbal, much of which was caused by the district being a rundown old working class neighbourhood, comprised of small and scruffy apartments (Femenías, 2004; van Lierop, 2012). The idea for a car-free urban eco-district was actually presented by local residents, and politicians and the new District Council supported the idea.

However, the local inhabitants, who mainly consisted of immigrants, students and a larger squatter population, strongly distrusted the local council (Femenías, 2004). Together with an environmental advisory company (BOOM), which acted as a kind of mediator, these two groups of actors had to develop a plan for the new district. The City District appointed two housing corporations for the development, but the project leader decided to add two more corporations in support of the 'green ideal' for the new neighbourhood (van Lierop, 2012). Given the environmental wishes, private investors were not interested in developing the site (ITDP, 2011). Ultimately, a co-operation of five housing corporations, called ECO-Plan, was formed for the project and dissolved after project completion, leaving the management in the hands of different organizations. Five architect offices and two contractors participated in the project. None of the architect offices had prior experience in sustainable building, but were chose for their architectural design capabilities. This decision was made to counteract the contemporary image of sustainable building being of low architectural quality. The architects for the urban design, however, were selected through a competition, initiated by the district council (ibid). In August 1993, a panel consisting of inhabitants, representatives from the district council and the project developer chose the plan made by architect Kees Christiaanse and landscape designer Adriaan Geuze for the development of the GWL-terrain. At the time of developing GWL, these architects were relatively new to the scene and very ambitious, and became renowned in later years (van Lierop, 2012). By November 1993, the panel along with the architect had worked together and finished the Urban Plan for the development (ITDP, 2011). The environmental advisory company was involved to make sure that the environmental aspects of the design were both innovative and realistic.

[29] The District Council 'Westerpark' was appointed in 1990.

By 1994, five design teams, representing an architect and a number of residents, were formed which were to design the various sections of the GWL-terrain. Local residents were thus heavily involved in the design and development of the project. It were the residents who wanted to push forward a new approach to development that focused on water and energy conservation, car-free living, reuse of resources, and community cohesion (ibid).

When the first homes were delivered in 1996, a residential umbrella organization (De Koepelvereniging) was instigated to monitor the environmental ambitions, encourage sustainable living and community involvement (ibid).

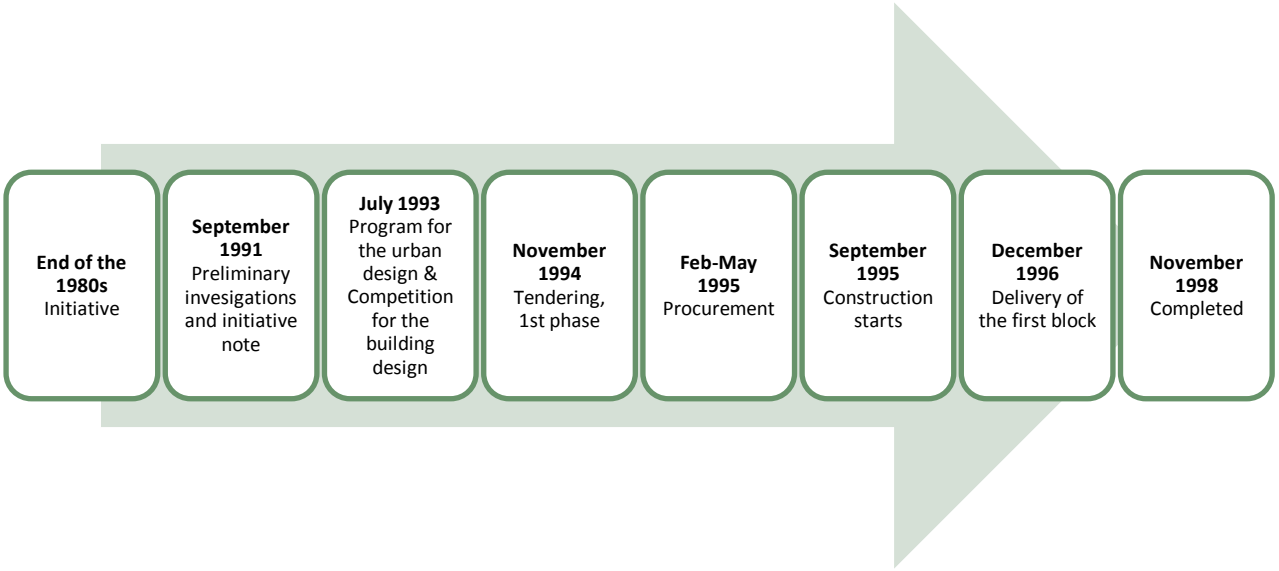


Figure 12: Development process

Vision, goals & means

The vision for the GWL-terrain was developed in cooperation with local authorities, private actors and local inhabitants through several meetings and workshops with developers and inhabitants. The vision for the project to be a green, environmentally friendly residential district where families with children could benefit from a car-free liveable area, served as a guiding principle for sustainable urban design. In terms of vision, every stakeholder, being the local authority, inhabitants, architects and corporations, shared the same ideal and vision for the project (van Lierop, 2012). The ambition was realistic in the sense that it included, after advise from external experts, reliable technologies and realistic measures. The overall level of project ambition of the GWL-terrain was, for the time of development, very high (van Lierop, 2012). The level of ambition is exemplified in the selection process (for the urban plan, selection of architects) and amount of research done in preparation of the project. Femenías (2004) notes that the environmental ambitions were regarded in all legal documents and programmes, and that environmental experts cooperated throughout the development to establish the environmental profile.

Although a shared vision was available, the formulation of goals to achieve sustainability was a difficult process because sustainability was not as crystallised as it is today. Many enthusiastic plans and proposals were placed on the design table, which were gradually selected on feasibility and costs[30]. It soon became clear that

[30] An environmental measure such as low temperature heating, for example, had been considered but was omitted because of the extra costs (van Hall, 2000).

sustainability would be a central topic, but would consist of a whole range of different measures, which together would produce the desired outcome. The DCBA model was used as a tool for the design process and setting ambitions, and does included some measurable goals. However, most of the measures in the project were chosen based on guiding principles, not necessarily to achieve measurable goals (van Lierop, 2012). During the interviews it was stressed that the project was supposed to be a demonstration project, not an experiment. In terms of sustainability, the focus has primarily been on proven and existing technologies in the design of the district (ibid). Along the way, project goals have been changed to some extent. Especially in the initial phase of the project, the vision and ambition were high and resulted in some ambitious targets for the project. However, due to regulations, practical reasons and other influences, goals had to be reduced somewhat. Mainly because the idea of sustainability or sustainable urban development weren't as crystallised as they are today, project developers have struggled to decipher what the concept exactly means and how it can be operationalised in the project (ibid). The specific choice was made not to do the most experimental but to develop to a level in which sustainable, economic and social aspects are incorporated but in line with the budget and liveability of the area.

In terms of budget and availability of resources, the project did not include substantial resources from different sources for the funding of the project (ibid). The main budget was provided by the urban renewal fund and through the corporations' budgets. The available budget for the project was substantial and will not be possible in this day and age anymore. The project did not benefit from extensive subsidies for the development of the project (ibid). However, some ' green loans' were received from VROM, the rental housing could profit from a 'green mortgage' and the municipality of Amsterdam provided additional subsidies for the extra costs used for sustainable building materials (ibid). Because the project was a national demonstration project, innovative techniques, such as the use of rainwater toilets, could benefit from national subsidies (Femenías, 2004).

However, this mainly relates to the urban design phase of the project. Previous research has shown that problems regarding the budget and time-pressure started during the building design phase (Femenías, 2004; van Hall, 2000). Many budgeting problems came up in the housing design, as there had been no inquiries in the beginning to check if the budget was indeed sufficient to support all ambitions. Both authors refer to the fact that 1994 was the last year in which subsidiaries were given for social housing, resulting in a rush during the building design. This resulted in less cooperation between architects and the environmental consultant, resulting in the fact that the consultant could only check the designs that were already completed. Unforeseen and unnecessary high budget exceeding were created because the "environmental measures were not integrated into the design but in later stage added (...)" (van Hall, 2000, p. 71). Resources in terms of environmental friendly building materials formed an important bottle-neck (ibid).

Figure 13: Aerial view GWL-Terrain[31]

Performance monitoring

The environmental consultants' role was to monitor the environmental performance of the project (GWL-Terrein, 2010). However, due to the fact that the external consultant was not involved in the building design, monitoring could not take place.

Transformations

Van Hall (2000, p. 71), reports that "there is a large need for how-to and innovation evaluation information". Much of the concepts and innovations applied in the development of the GWL-terrain were first applied. As it turned out to be difficult to access practical evaluation information regarding such urban design concepts, "for long periods measures were not or insufficiently taken and development sometimes still needed to take place during execution (ibid: 71)." In the urban design sufficient time and budget was made available for environmental consultation, but during the building design phase the availability of knowledge and performance decreased as consultation was only sporadically used (van Hall, 2000; Femenías, 2004). Because of the novelty of the concepts applied, the environmental advisor sometimes too had insufficient knowledge available (ibid). Performance was further inhibited due to the introduction of new materials, and provided difficulties in the performance by contractors as it formed a bottleneck in common practice and standard procedures in the building industry and in regulation (Femenías, 2004). The internal learning capacities were also threatened as the developer organisation dissolved after completion, leaving the knowledge acquired during the development to get dispersed and lost (ibid).

Participation & Communication

Although the project had a high level of participation amongst stakeholders, the process also suffered from

[31] http://www.kcap.eu/en/projects/v/gwl_terrein/

communication problems (Femenías, 2004). Because of the above-described unclarities in goals and targets, and the late involvement of some consultants, the level of trust between actors decreased. The project exemplifies a high focus on consensus building. Because of the distrust amongst certain actors and the fact that the participating public had higher ambitions than the project organisation, communication between stakeholders involved had to be intensified to solve problems (van Lierop, 2012). This often meant that stakeholders engaged in lengthy discussions about goals, targets and ambitions. Ultimately, the level of participation has been exceptionally high; especially the fact that residents were actively involved in the early process of designing the new district is exemplary to the level of participation in the area (ibid).

However, external communication has been affected by the fact that the organisation and networks were dissolved soon after completion, resulting in the fact that few actors had time to evaluate their own work or disseminate the results and experience, causing valuable knowledge to be lost (Femenías, 2004).

Environment

The case of GWL-terrain has some specific factors that were external to the planning approach, which helped to expedite the development of a low-carbon neighbourhood. Firstly, the project is symbolic to the Dutch 'polder mentality' or the inclination to reach consensus trough sustained, and sometimes very lengthy, dialogue and cooperative processes. Moreover, the newly formed district council consisted of young, ambitious individuals and was run by a coalition of Green Party and social-democratic councillors (the labour party, PvdA). The high degree of community involvement shows that the local authority was open to different viewpoints, is receptive to grass-roots influence over the project and displays the proactive nature of local residents. In this respect, the fact that the adjacent 'Staatslieden' neighbourhood had changed into a deprived neighbourhood, attracting mostly students and a large squatter population, resulting in a need for housing and a centralisation of local citizens who were to too soft spoken. The local inhabitants wanted a better residential area, and actively lobbied for a 'green' neighbourhood.

Continuity

Although the project has largely benefitted from a continued presence, from the initiation phase to delivery, of a number of key stakeholders (van Lierop, 2012), the above described role change of the environmental advisor in the housing design phase was caused by a change in project leader (van Hall, 2000). This affected effective change management and overall performance of the project. Reported difficulties in communication, participation and difficulties in the process as compared tp normal procedures in the building sector, affected the continuity of the project.

But, despite the process being overly complex and labour-intensive as a result of the high level of participation and cooperation, the overall process of developing the new district has been quite smooth (van Lierop, 2012). Crucial to the development of the district has been the continuity of actors involved in the process. Several key players in the city district, architect firms, local citizens and environmental experts have been involved from the initial phases to the delivery of the project. This has facilitated the continuity of the vision and concept in challenging times and has furthermore facilitated the strengthening of trust between actors.

Financial risks were minimized by the availability of a large urban renewal fund and the corporations who had significantly healthier budgets than presently. Moreover, the project was developed in a market where sales were guaranteed due to the high demand for housing (ibid).

3.3.2.2 GOVERNANCE ANALYSIS: ROLE OF THE GOVERNMENT

The above analysis of the developing process for GWL shows that the degree of local government control over implementation has been moderate and that planning was proactive, ideological, visionary and promoted spatial strategies. This visionary planning is characterised by intensive communication and collaboration, providing the neutral grounds upon which different conceptions of 'the good' might be fostered (Kasioumi, 2011). The author also mentioned that in this type of planning, the promotion of the sustainability vision should be done by translating sustainability according the different interests of the stakeholders involved.

When the model of Driessen, et al., (2012) is used to analyse and evaluate the governance approach taken in the development of the GWL-terrain, we see that much of the factors in the model mainly touch upon the '***interactive governance approach***'. Because the design was commissioned and initiated by the local authorities (first city of Amsterdam which transferred the responsibility for development to the newly formed District Council), the *initiating actors* for the development of GWL has primarily been the central government agency. However, the private sector and civil society were 'granted' preconditioned roles as well. Due to the level of organised bottom-up pressure from local residents, however, it can be argued that the government had little room for choice whether or not to 'grant' these actors preconditioned roles. Ultimately, the stance taken on *stakeholder position* provided predominantly equal roles for all network partners. However, the role of the environmental consultant changed during the process and could not exert the same involvement in developing the area as previously. In a way, this changed involvement was determined by a self-governing entity, the project team, and caused by a change of project leader. This leans upon the characteristics of self-governance. Although policies for sustainable building at the time of developing GWL-terrain was very new in Amsterdam, there were some other projects throughout the country with which the developers could compare themselves (van Lierop, 2012). However, national or local policy in support of sustainable urban development were very underdeveloped, but some policy developments were attained at the national and international level. The *policy level*, therefore, could be characterised as on multiple levels, but was mainly focused on the local level in which policies were devised for the specific local context of the project. Regarding the *power base* of actors involved, the emphasise was on legitimacy, rather than coercion, competitiveness or autonomy. Through the participatory nature and emphasise on equal roles for all stakeholders involved, agreement was reached on the different roles, procedures and processes in the strive for creation of trust and knowledge (ibid).The *model of representation* for GWL shows the characteristics of a partnership (however not formalised). The fact that residents, together with private actors worked on developing the area is exemplary to the participatory public-private governing arrangement in the model. The *rules of interaction* of involved institutions show a mixture of formal and informal rules because of the innovative character of the development. The actors involved had to operate in an arena with fixed rules and procedures, exemplified by the fact that contractors were inhibited by common practice and standard procedures in the building industry and regulation (Femenías, 2004). However, the *mechanisms of social interaction* can again be characterised as 'interactive' as the focus was on learning during the process, deliberations and negotiations. The local government, together with private actors and civil society actors cooperated and decided upon tailor-made and integrated *goals and targets*. The *instruments applied* for the development of GWL-terrain shows a mixture of incentive based instruments such as subsidies, but also of negotiated agreements. The level of *policy integration* in the Netherlands was very much sectorised at the time of development (ibid). The integration of so many different ambitions, touching different policy sectors such as water, energy, and social sectors required a new, collaborative intensive approach to planning. Ultimately, policy and interests could be combined in the development of the GWL-terrain. The policy aim for the District Council to provide housing for families with children and the demand for a green, car-free residential area from civil society converged in the project. Lastly, *the policy-science interface* shows the interactive and transdisciplinary character of the governance approach. Both expert and lay knowledge was considered in networks of stakeholders, with an emphasis on integrated and time-and-place specific knowledge.

3.3.3 STIMULATING FACTORS

The above analysis of the planning process for the GWL-terrain presents certain underlying factors in the local context of Amsterdam that facilitated the realization of the sustainable neighbourhood. Some factors relate to the planning process, whilst others are independent of the chosen approach.

Firstly, the initial stimulus for the development of the project came from the '***specific local context***' of the deprived neighbourhood adjacent to the area of the GWL-terrain. It is here where the ***'bottom-up pressure'*** for change was established. The fact that the population consisted mainly of unhappy, green-oriented citizens and a large squatter population with a history of demonstration, made them a powerful source of change.

Moreover, the ***'specific cultural context'*** of the Netherlands, referring to the Dutch 'polder mentality', provided the grounds for the '***participatory process***'. Van Hall (2000) concluded that the high level of cooperation in an interdisciplinary team, in which an 'innovation champion' (referring to the environmental advisor who spurred the development and implantation if innovations) takes part, was very important and crucial to the success of the project. This is exemplified in the fact that the urban design included the external environmental advisor, and the building design did not include the same level of cooperation, resulting in problems during the housing design phase and the subsequent use phase (ibid).

Furthermore, with the Brundtland report fresh in mind, ideas were formulated at the national level regarding sustainability and a first National Environmental Policy Plan (NMP1) was published in 1989. One year later, the plan was updated to NMP+ and included policies for the building sector. These initial explorations and developments created a somewhat '***sympathetic political climate***' at the national level for the creation of sustainable urban districts. At the city district level this was further exemplified by the suggestion from a green-oriented councillor to create a sustainable neighbourhood.

The GWL-case further shows the importance of '***political leadership***' coming from the district council. The fact that it was a newly formed district council, comprised of young and ambitious member, aided the drive for the creation of a demonstration project (van Lierop, 2012). Moreover, the new district council was run by a coalition of Green Party and Labour Party members, opening up the grounds for green oriented urban development. The high degree of community involvement shows that the local authority was open to different viewpoints, was receptive to grass-roots influence over the project and displays the proactive nature of local residents.

However, despite the level of ambition and receptiveness for the ideas of a sustainable neighbourhood at the part of the district council, the participating local inhabitants had higher ambitions than the project organisation (Femenías, 2004). The lobbying, participation and pressure exerted by a group of ambitious local inhabitants has stimulated the formulation of more ambitious goals (van Lierop, 2012). The specific group of inhabitants who worked together with architects and the local authorities on the development of the new district, provided '***community leadership***' in the sense that in made the project more ambitious on some levels, especially the car-free urban design.

Furthermore, the land for the GWL-terrain was in '***municipal ownership***' and the district council took the initiative to buy-out the adjacent factory that would have caused air quality problems for the new district. The fact that the land was in municipal ownership alleviated the problem of potential conflicts arising from a situation with different private landowners.

Particularly in relation to the stimulating factors for realizing a demonstration project like GWL-terrain, Femenías (2004) has listed some important prerequisites that, according to the project leader at the local municipality, are crucial to project success, namely: "political enthusiasm, willingness to pioneer and to accept extra costs, coaching by an environmental advisor, cooperation between developer and architect, well-organized public participation, ability to negotiate with public works services and early recruitment of future tenants".

Van Lierop (2012) adds that a project runs well when there is a shared ideal or passion. In the case of the GWL-terrain, the same ideal was shared at the level of the district council, inhabitants, community

organisations and housing corporations. Moreover, all stakeholders had a certain interest in participating and working towards a shared ideal. The housing corporations, for example, were keen to show that they were able to build private housing as well. Until then, housing corporations typically were building social housing only. This combination of political enthusiasm, private and public interest, sharing a certain pioneers vision, proved to be absolutely crucial to the development of GLW-terrain. To a great extent, this culmination of shared ideals and interest was a '***window of opportunity***'. At the political level, support was created because the project combined different policy aims, rather than focussing solely on sustainability. Multiple driving themes[32] for the development alleviated resistance and perception of risk (ibid). Moreover, the support from the external environmental advisor has been crucial in the development with its supporting research and advise.

3.3.4 CONCLUSION

At the time of development, the term 'sustainability' or 'low-carbon urban development' was not as studied as it is today. Nevertheless, up to this date the GWL-terrain is often referred to as a best practice case for sustainable urban design (Christiaanse & Salewski , 2009; ITDP, 2011). Interestingly, however, the central aim for the design of GWL was not 'sustainability' itself, but a 'good urban design' for the new neighbourhood in Amsterdam (Christiaanse & Salewski , 2009). Although success project features include environmental measures such as rainwater collectors, high density urban development and a mix of functions, and a participatory design of public and green space, many of the environmental goals, measures and technical solutions used at the GWL-terrain are no longer innovative (van Hall, 2000). Yet still, the project has been an important influence in the development of sustainable building in the Netherlands (ibid). The case study, next to an overview of stimulating factors in the development of GWL, provided some further lessons for future low-carbon development.

Firstly, the case exemplifies the importance of defining quantifiable and realistic goals for the sake of good internal and external communication, and the ability to monitor progress. Such evaluations should be planned and budgeted from the start of a project (Femenías, 2004). If evaluation is not planned for, it will be difficult to monitor the effect of the project on flows related to the urban environment such as energy, waste and water flows.

Secondly, although the implementation of a multitude of environmental measures could theoretically improve sustainability across the board, lowering carbon emissions in across multiple sectors such as transportation and energy, the wide variety of ambitions at GWL-terrain has resulted in no single high-points (van Hall, 2000). Arguably this could be the result of sustainability concepts in the built environment not being as clearly stipulated as they are now, if at all. Another explanation can be found in the miscalculation between the ambitions, time-plan and the financial situation, resulting in more effort being put in the early stages of the urban design, rather than throughout the whole process including the building design phase (ibid). This exemplifies the need for rigorous ambitions, a sound time-plan and sufficient effort being put into determining the match between budget and ambitions. At the GWL-terrain, this disparity has led to lower levels or the exclusion of initial ambitions, in particular for the building design (ibid). Thus, depending on the size of the budget and the level of ambition, projects should well determine the focus of environmental efforts, as it is arguably more efficient to focus on one sector and do well, than to achieve no single high-points and achieve fractional results.

Moreover, in some situations it appears to be more efficient to rely on familiar or proven technologies, rather than relying on the most innovative, but experimental technologies as "unproven innovations could turn out negatively in the use phase" (Abdalla, 2012, p. 107). Depending on the type of project, being experimental or demonstrational, a decision should be made upon the level of innovation. It might well be possible that the implementation of more experimental environmental innovations requires more extensive research and

[32] Referring to the idea of providing a livable, green area for families with children, in which social and environmental aspects were combined.

preparation for the local context in which they are applied. At the GWL-terrain, “careless preparation of the construction, the involvement of untried environmental innovations, as well as the complexity of the project with unconventional design and a large variety of designs for flats” has resulted in problems in later phases of the project that determine the outcome of the project itself (Femenías, 2004, p. 136). Although subsidies could spur the development of low-carbon development, the availability of subsidies for the GWL-terrain has led to a rush during the building design, resulting in missed opportunities for environmental measures to be implemented or evaluated (ibid).

Lastly, despite the fact that there was shortage of domestic and international visitors to the GWL-terrain, there hasn’t been a follow-up on the car-free housing concept in Amsterdam or elsewhere in the Netherlands, and new housing proposals have returned to conventional parking management (Christiaanse & Salewski , 2009). It appears that, without the bottom-up pressure from local residents demanding such an innovative approach to urban design, a car-free neighbourhood might well be too progressive for the time being.

Case Study

Vauban, Germany

3.4 VAUBAN (FREIBURG, GERMANY)

The suburban redevelopment project '*Quartier Vauban'* (QV) is situated in the foothills of the Black Forest in Freiburg, south-west Germany, and is "one of the most celebrated model sustainable districts" (ITDP, 2011, p. 96). Vauban illustrates the development of a sustainable urban district, adopting a cooperative planning process and socio-ecological values (Schroepfer & Hee, 2007). Often referred to as the 'solar capital city of Europe', Freiburg is a regularly mentioned forerunner in environmental practice and policy. Freiburg-Vauban was presented at the UN Habitat II Conference of 1996 in Istanbul as 'German Best Practice' because of its cooperative planning process.

Vauban "was used as an army base since the 1930s until 1990 when the French military presence ended and activists created the slogan 'barracks into dwellings' in light of an acute shortage of homes in the Freiburg area (Schroepfer & Hee, 2007, p. 343)." Construction of the 41-hectare urban regeneration project began in 1998 on a former French army barracks site and was mainly completed by 2006, although a few lots are still being developed (ITDP, 2011; Kasioumi, 2011). The sustainable urban district is now home to 5000 residents and provides 600 on-site jobs.

As will be discussed in the following paragraphs, Vauban has important lessons regarding government & regional policies, transport, waste and urban design. Though the biggest lesson is about public engagement and the incorporation of social, economic and environmental principles. Resultantly, Vauban has received national and international recognition as an exemplary sustainable city district (Schroepfer & Hee, 2007).

Figure 14: Solar roofs at Vauban district[33]

[33] Source: http://www.solaripedia.com/images/large/853.jpg

3.4.1 CHARACTERIZATION OF THE PRACTICE IN PLACE

The following chapter will describe the key elements of the Vauban development. It aims to provide an overview of the LCD strategy by discussing the "*field of activity*", "*government & project ambition*", "*implemented technologies*", and the "results & problems in use".

3.4.1.1 FIELD OF ACTIVITY

In Vauban, carbon reductions have been achieved through the implantation of efficient energy systems, high-energy standards in buildings, the generation of low-carbon energy and schemes to promote alternatives to fossil-fuelled cars. The focus lies on transportation and energy.

Transport

Quartier Vauban is exceptional in its mobility concept (Kasioumi, 2011). Planned around the concept of 'green transportation', the transportation plan for Vauban was not aimed at developing an entirely car-free residential district, but rather to reduce car-use and increase quality of life altogether. Resultantly, two concepts which usually are not integrated into one concept were implemented; "parking-free" and "car-free" living. In relation to "parking-free" living, the development plan for Vauban prohibits the building of parking space on private property for large parts of the residential district (Schroepfer & Hee, 2007). Instead, vehicle owners are obligated to purchase or lease a parking space in a community car parking near the edge of the area. Moreover, cars are only allowed into the residential area for pick-ups and deliveries. In support of the "car-free" living concept, residents without a private car are exempted from the legal requirement to participate in the community car park. The car-free residents therefore do not subsidize the car parking, as it would be anywhere else. Car-free residents, organised in a special association, thus save the substantial costs of a parking space. Pedestrian and bicycle paths form a well-connected, efficient and green transportation network throughout the district in support of the car-free living concept. Moreover, a car-sharing program offers twelve cars, five of which are located in the Solar Car Park (ITDP, 2011). Housing units and parking spaces are sold separately and, at the time, resulted in an additional € 13,500 for car owners (Schroepfer & Hee, 2007). On a yearly basis, residents must declare their status of car ownership.

Several incentives make public transportation more attractive than private transport. First, a special mobility package was offered for the first parking-free development (ITDP, 2011). Those residents who would join the car sharing program received a one-year free pass for all public transportation within Freiburg and a one-year 50% reduction on every train ticket. Tickets are available for low fares in absolute terms and holders of a RegioKarte benefit from free travel for a second adult on Sundays. Moreover, mobility guarantees are available by the municipal transit operator, offering a free taxi service in the event of missed connections and delays (ibid). These incentives compare favourably to the monthly car park service charge of € 70. Public transportation to Freiburg by tram "was not completed until 2006, which was the latest date by which under state legislation, revenue from the sale of land in Vauban could be used to fund some 30% of its total costs (Schroepfer & Hee, 2007, p. 7)".

Waste and Water

According to Scheurer & Newman (2009), the Vauban conceptualization and practical operation addresses three important topics associated with waste management:

- *Material flows associated with the buildings themselves*, the reduction and measures of reusing or recycling building materials. In Vauban, housing cooperatives designed the most durable components of buildings (its structural shell) with flexibility of usage in mind. The embodied energy of construction materials was relatively low in terms of production. However, the embodied energy for transportation to and from the site was quite high. Without requiring full or partial demolition, buildings were designed to accommodate a wide range of possible future modifications of internal partition and use.

Materials for the internal fit-out of the buildings were assessed on their energy performance and durability;

- *The consumption of durable goods associated with household use, and the reduction of its waste volume.* As will be described below, non-profit owners or rental cooperatives developed most of the residential clusters of Vauban. The community-oriented nature of these tenure forms has allowed for the use of appliances with a high embodied energy content, such as washing machines, as shared services. Because such appliances are not owned privately, the number of appliances, but also larger machines such as motor vehicles, were reduced at the neighbourhood level. However, the carbon impact of such measures is relatively low compared to areas such as food consumption and personal transportation;

- *User-oriented solutions to reduce household waste, and to recycle the components of what still remains.* Household waste is separated into recyclable components and most housing cooperatives have user-operated composting systems in the shared green open space under community stewardship.

In relation to water, 80% of the residential area is designed to infiltrate rainwater back into the ground. The ecological sewage system transport human wastes into a biogas plant. The anaerobic fermentation of such wastes together with household waste generates biogas, which is used for cooking. The remaining grey wastewater is cleaned in biofilm plants and returned to the natural water cycle. Water conservation is addressed through the collection of rainwater and use indoors, green roofs, permeable pavements, unpaved tramways and drainage sloughs.

Urban Land Use and Spatial Structure

Supporting the 'district of short distances' concept, every home is built within walking distance of schools, business, tram stops and shopping centres. Moreover, Vauban is designed to integrate into a regional network of open spaces, connecting to important green links to nature reserves in the neighbourhood. A number of shared open spaces are converted under permaculture principles to support the small-scale cultivation of food (Scheurer & Newman, 2009). Next to a low-energy standard for buildings and the parking-free concept, a number of regulations to ecological building such as the greening of roads, rainwater infiltration and the conservation and planting of trees are included in the development plan. Moreover, the new district largely consists of four story row houses and features a net density of 90-100 units per hectare.

Energy

In relation to energy and the reduction of carbon emissions, different approaches were adopted in Vauban. Some parts of the new district involved community heating, whilst other parts were connected to the district heating system, powered by biofuel. Moreover, some households generate all their energy from solar input (Williams, 2012). The community car park, for example, is equipped with photovoltaic panels and is hence known as the 'Solargarage Vauban'.

Energy management in Vauban was designed to meet two key objectives (Scheurer & Newman, 2009, pp. 7-8):

- *Improved energy generation and distribution*: Although Vauban inherited a functioning district heating system, the prevailing centralisation of heat and power generation the regional level did not coincide with the aspired level of control over energy sources in the community. Particularly in relation to the ratio of fossil and renewable fuels Vauban had deviating aspirations. Local advocacy groups lobbied for a CHP-plant to allow for the much higher scope of self-determination with regards to the district's energy supply. By 2002, a neighbourhood-scale CHP-power station, fuelled primarily on forestry waste products, was installed to take over the local distribution network, making Vauban a carbon-neutral neighbourhood in terms of stationary energy use;

- *Improved building technologies and building design*: Vauban was already subject to a city-wide low-energy building standard, known as the 'Freiburg Low-Energy Standard'[34], adopted by Freiburg during the 1990s and adopted at the federal level in 2001. However, Vauban moved beyond this standard during the planning and implementation process, resulting in "one of the most significant concentrations of passive houses and plus-energy houses in the temperate climate belt of Europe". Supported by high insulation, solar thermal and photovoltaic systems, intelligent ventilation systems, compact and clustered building envelopes and residents with the knowledge and sense of ownership to use these features to the optimum.

3.4.1.2 GOVERNMENT & PROJECT AMBITION

According ECN (2011), there are a number of existing experiences with the development of Low-Carbon-Development Strategies (LCDS), or integrated national climate strategies, which can provide lessons for future strategies. Some date back more than 20 years, some of which contain elements of low-carbon development strategies. At the *national level*, Germany is mentioned in relation to its 'Inquiry Commission on Preventive Measures to Protect the Earth's Atmosphere' in 1990, which already suggested an emission reduction target for Germany of 25% until 2005, relative to 1989. Although the German 2005 emission reduction target was never met, Germany as a nation is often mentioned as a leader and example to other countries in relation to sustainable development and the reduction of CO_2 (UN-Habitat, 2011; European Commission, 2011).

At present, Germany has published its 2009 energy policy roadmap, aiming to boost energy sustainability. The ambition is to raise the share of renewable energy to 30% of German electricity by 2020 (European Commission, 2011). The main stimuli for low-carbon growth in Germany are energy security, secure job creation and the reduction in greenhouse gas emissions. Resultantly, the German government has implemented several initiatives to spur the development of sustainable energy production as well as to spur the development of green growth technologies in support of the nation's economy. The nation has expressed the desire not to be dependent on energy imports or nuclear power. Germany hopes both its 'Renewable Energy Sources Act' and the proposed 'Efficiency Standards Act' can enable renewable energy to become a long-term replacement for nuclear power and inefficient conventional power stations.

As a global leader in renewable energy, Germany was five times above the EU(27) average in 2007 for primary production of renewable energy at 28 million tons of oil equivalent (ibid). Through legislations such as the 'Renewable Energy Sources Act' and eco-taxes, renewable sources are promoted trough feed-in tariffs. The roadmap established a number of principles through which the country hopes to achieve a number of key environmental targets (UN-Habitat, 2011; European Commission, 2011):

- Cut greenhouse emissions by 40% of 1990 levels by 2020;
- Increase energy efficiency by 3% per annum;
- Increase the share of renewable energy to:
    - 50% of primary energy consumption by 2020;
    - 30% of gross power consumption by 2020;
- Increased usage of biofuels in order to reduce greenhouse gas emissions by 7% by 2020;
- Double the contribution of combined heat and power (CHP) technologies to 25% of power generation in 2020;
- German electricity consumption should be reduced by 11%, based on 2005 levels by 2020;
- A 20% reduction in carbon emissions generated by transport is envisioned trough road taxes, reduced public transportation taxes, and the introduction of the 'Biofuel Quota Act' which is intended to reduce the carbon emissions through the use of biofuels.

[34] The standard sets the permissible heating energy need of new residential constructions at 65 kWh per m^2 per year.

Table 18: Germany's commitment to international treaties on Climate Change

(International) treaties on Climate Change	Ratified/Signed?	When?
UN Framework Convention on Climate Change (UNFCC)	V	1993 (signed in 1992, went into force by 1994)
Kyoto Protocol	V	2002 (signed in 1998, went into force in 2005)
Agenda 21	V	1992 (went into force since 1996)

Progress towards Kyoto target

Germany has steadily decreased its emissions since 1990 (EEA, 2011). Due to fuel switching, increased energy and technical efficiency, energy-related emissions decreased by 25%. Interestingly, the waste sector in Germany shows the highest reduction due to increased recycling and the ban on the disposal of biodegradable waste on landfills (ibid). On average, 2008-2010 emissions in Germany were 22.6% lower than the base year, and well below the burden-sharing target of -21% for the period 2008-2012. In the sectors not covered by the ETS, emissions were 3.1% lower than their respective target. Germany was therefore on track to meet its Koto burden-sharing target by the end of 2010 (ibid).

At the *local level*, Freiburg is known internationally as one of the birth places of the green movement (ICLEI, 2009). The city and its inhabitants have been concerned with sustainability since the 1970s, with Freiburg publically advocating solar energy use of atomic energy since 1986. Starting with the intention to move away from nuclear energy towards the use of renewable energy sources, an energy concept for Freiburg was developed. The first Climate Protection Plan (*Klimaschutzpolitik* – KSP) was adopted in 1996, setting a target of 25% CO_2 reduction by 2010, based on 1992 levels, which called for action in the fields of transportation, waste and industrial production, as well as energy. The plan was reaffirmed in 2007 with the changed ambition of a 40% reduction in CO_2 levels by the year 2030 (ibid). Throughout this period, the participation of local inhabitants, politicians and the business sector has been an essential part in the Action Plan's development and implementation process.

Table 19: Freiburg's commitments to (international) treaties

Treaty	Signatory?	When?
ICLEI –Local Governments for Sustainability	V	1990
Covenant of Mayors	V	2008
Aalborg Charter	V	
Aalborg Commitments	V	2006

The *project specific* ambition for Quartier Vauban was formulated as the objective to implement a residential district in a co-operative, participatory way that meets ecological, social, economic and cultural requirements, such as[35]:

- Balance of working and living areas;
- Balance of social groups;
- Conservation of the 60-year-old trees and the biotopes of the bordering creek;
- A transportation concept encouraging car-free living and placing restrictions on private car-ownership;
- All buildings constructed at least with improved low energy standard;
- Extensive use of ecological building material and solar energy;
- Infiltration of rainwater into the ground, ecological sanitary systems;
- An environmentally friendly district heating system with renewable energy sources;
- A district-of-short-distances with daily needs close to its residents;
- Family and children friendliness;
- Priority for private developers and co-ops over corporate investors.

According to Abdalla (2012), project Vauban had ambitious objectives including: the prevention of water run-off and reuse of rainwater, promoting knowledge dissemination, minimizing impacts from transportation, reducing energy consumption to meet the low-energy standard of 65 kWh/m^2/yr for heating energy, promoting a social housing mix, and ensuring a healthy indoor air quality. Additionally, 100 units were to be built according to 'passive house' standards (15 kWh/m^2/yr) or to a 'plus-energy' standard (producing more energy than they consume). The aim was to persuade people to change their way of life and, in particular, to reduce car usage and shift to cycling, walking and public transport. Moreover, stationary planning provisions required developers to achieve a very high standard of energy efficiency (see next paragraph), going beyond the already progressive national standard (MEFL, 2011). Some developers in Vauban went even further and built according to the EU standard of PassivHaus[36].

3.4.1.3 IMPLEMENTED TECHNOLOGIES

Vauban incorporated a number of technologies and systems in support of its objectives. Most buildings feature photovoltaic panels and solar-supported heating systems as well as intelligent ventilation with heat-recapture devices. District heating and sewage treatment was initially provided through centralised facilities outside Vauban (since most infrastructure was already in place due to the former military use of the site), though most buildings have rainwater collection facilities and run some applications like toilets and garden watering from them. A small number of projects have incorporated innovations such as a vacuum converter for sewage and organic waste, producing reusable biogas. Low energy consumption for heating is achieved with the improvement of thermal insulation of the building envelopes, and by taking advantage of ventilation heat recovery and passive solar heating (Abdalla, 2012).

[35] http://www.vauban.de/info/abstract2.html

[36] Meaning that almost no energy is used for the heating or cooling of the building

3.4.1.4 RESULTS & PROBLEMS IN USE

According to Scheurer & Newman (2009, p. 9), the "technical aspects of Vauban have been largely successful across the board" and, most notably, are its achieved results in stationary energy[37], where it achieved a carbon neutral status. Moreover, the residential district is "radically less car dependent than most areas built in the past 50 years" and is "a model of how the green and brown agendas can be integrated"(ibid: p. 9-10).

Energy

All buildings in QV meet, and in some cases effectively challenge, the local energy efficiency code of 65 kWh/m^2/yr, known as the 'Freiburg Low-Energy Standard', which became a federal standard after 2001 (Scheurer & Newman, 2009). The compulsory improved low-energy standard in QV resulted in an average energy consumption of 45kWh/m2/yr (Abdalla, 2012). The objective to reach an energy demand of 65 kWh/m^2/yr for space heating thus has been met at Quartier Vauban. Moreover, 92 passive houses have been developed in Vauban which achieved 15kWh/m^2/yr and 10 positive-energy houses (producing more energy than they consume) have been developed (Energy-Cities, 2008). The positive-energy houses, thanks to extensive PV installations, produce 36 kWh/m^{2}yr of electricity that is fed back into the grid (Kasioumi, 2011). In comparison, the average standard for newly built between 1995 and 2000 is about 100 kWh/m2/yr in Germany, whilst the standard for older houses is around 200 kWh/m^2/yr.

The district heating grid is powered by a CHP-plant, fuelled with 80% woodchips and 20% gas, and with 2500m2 of PV panels (producing energy directly) and 500m2 of solar panels (used for the production of heat) is estimated to be one of the largest solar districts in Europe.

A 2002 research project by Öko Institut provided evidence, although based on assumptions and not actual measurements, for the potential overall reduction in use of minerals and production of CO^2 and SO^2 emissions (Kasioumi, 2011). Most notably, however, is the conclusion that 'passive houses' provide 30% energy costs savings (while the surplus costs were only 3% compared to conventional houses), and that the 'plus-energy houses' use only 15% of the energy need by conventional homes. Resultantly, the heating costs of a plus-energy house amount to 150 to 200 euros/year, less than ten per cent the costs of a conventional house (ibid).

In relation to the sustainable ventilation and air conditioning systems (HVAC) used in Vauban, Abdalla (2012) reported that the project failed to control resistance to change residents' behaviour in using such systems according to its sustainability principles. The project's success is greatly influenced by the way in which residents use such systems. Some thermal discomfort in dwellings has been reported, but unfortunately these complaints are not solved yet (ibid). Despite these problems in use, the average carbon footprint of Vauban residents' is 0.5 tonnes per capita, compared to 8.5 tonnes per capita per annum for Freiburg residents (Williams, 2012).

Transport

Since 2009, the municipal transit operator has switched to 'green energy' to power the tram system, and many of the vehicles have regenerative braking which returns energy to the wires for use by other trams (ITDP, 2011, p. 102).

An extensive research conducted by the ITDP (2011) shows that the amount of car parking spaces is <0.5, and per 1000 residents, 160 privately own a car (see Figure 15).

[37] 'Stationary energy' includes all fuels used in electricity generation and in the direct production of heat in the industrial, commercial, and residential sectors. It does not include energy used for transport or emissions from industrial processes.

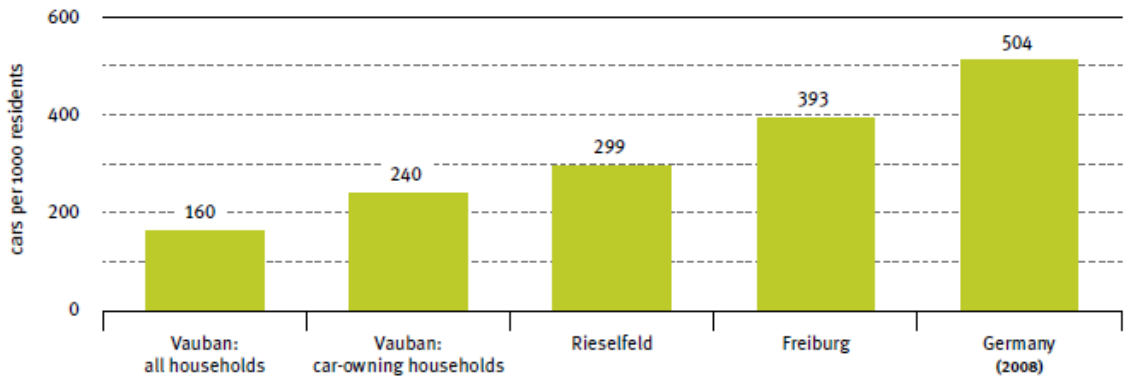


Figure 15: Vauban Car ownership compared to surrounding areas (ITDP, 2011)

Compared to the reference district Rieselfeld, Vauban residents use non-motorized transportation significantly more often (see Table 20). However, the late adoption of the tram extension, which connects Vauban to the centre of Freiburg, impeded with the transit-oriented activity from the beginning. Overall, car use in Vauban is about half of that in the reference district and Freiburg.

Table 20: Mode share for all trips

	Vauban	Rieselfeld
Car	16%	30%
Public transit	19%[38]	25%
Bicycle/walking	64%	45%

By 2002, 39% of Vauban households had registered with the car-sharing organization, 59% of which in car-free households and 11% in car-owning households. Moreover, the report shows that 70% of respondents without a car, now use car-sharing more often than they did before moving into Vauban. In relation to this, 81% of the Vauban inhabitants of car-free households previously owned a car; 57% of which gave of their car before moving to the sustainable district (ibid). It seems that a great number of people were influenced by the district's characteristics to give up their car before moving in to Quartier Vauban. However, the report also shows that car-owning households keep using their car for 'bulk shopping', apparently "one of the most difficult trip types to shift away from the private car" (ibid: p. 104). Whereas 6% of these trips by car-free households are made by private car, 73% of these trips are made by car by those with access to a household car. This suggests that car-owning households did not find the incentives to switch to non-motorised transportation for such trips significant enough to change their behaviour in correspondence with the district's principles. Similarly, 67% of car-owning residents in parking-free streets reported being dissatisfied with being unable to park in front of their home. The report concludes that given the fact "that almost 60% of parking-free households have a car, [it] implies that approximately 40% of these residents considered Vauban's advantages to outweigh this inconvenience (…)" (ibid: p. 105). Conversely, 81% of residents from car-free households declared to find life without a privately owned car to be 'easy' or 'very easy' in Vauban, attributing to the quality of the 'district-of-short-distances' concept and the non-motorised transportation infrastructure in Vauban.

[38] Prior to the tram extension to Vauban in 2006

Waste & Water

The objective to prevent water run-off and increase water infiltration into the ground has been met. Water run-off is reduced and water infiltration increased in about 80% of the district (Abdalla, 2012). Most rainwater is collected and used in houses are filtrated back into the ground. Moreover, the objective to use ecological sanitary systems has been achieved through the transportation of sewage via vacuum pipes into the biogas plant and is converted into biogas (ibid).

Urban Land-Use & Spatial Structure

At just over 3 km from the city centre in a rather small and compact city of 200,000, Vauban is in a peripheral location in its urban context. In relation to the district-of-short-distances, the ITDP (ITDP, 2011, p. 104) reported that a majority of residents prefer to do daily grocery shopping within Vauban, "reflecting the excellent provision of local facilities". However, Vauban's anticipated 600 jobs at a population of 5,000 inhabitants constitutes a well-meant start at establishing a mixed-use district, but is still far away from being employment self-sufficient (Scheurer & Newman, 2009).

Despite the difficulty of implementing a restriction of sourcing area for materials and contractors, the objective to use environmentally friendly construction materials in the development of QV has been met. According to Abdalla (2012), project stakeholders were stimulated and well educated to use eco-friendly materials, but the limitation to its sourcing distance was never established.

Most notably, however, the development of Vauban failed in some respects to meet is ambition to create a balance in social groups within the district. With a considerable attraction to families and individuals whose primary interest it is to purchase a residential property, in which the ecology is merely an added bonus, it "is hardly surprising that the first thing to notice upon entering Vauban is the sheer number of young children roaming around (…)" (Scheurer & Newman, 2009, p. 10). Over half of the Vauban households consist of four or more persons and over 75% of Vauban households have children under the age of 18 years old (ibid). Moreover, if Vauban suffers from anything, it would be the middle-class monoculturalism as its residents are largely European, young and wealthy. With 75-80% of private homeowners in Vauban, the project failed to create a balanced social housing mix due to the cancelled governmental subsidies in support of a social housing mix (Scheurer & Newman, 2009; Abdalla, 2012). Apartments especially for low-income residents remain limited despite the private initiatives such as the shared-ownership association (co-operative GENOVA) for the purpose of creating self-governed rental housing on Vauban (Scheurer & Newman, 2009).

3.4.2 DEVELOPMENT PROCESS AND GOVERNANCE

In the paragraphs below, the main characteristics of the planning process and governance approach will be discussed.

3.4.2.1 DEVELOPMENT PROCESS

Control of the planning process: main actors, roles & responsibilities

Vauban is a multi-faceted innovation project with many key stakeholders. Several public and private sector stakeholders redefined traditional roles to achieve an integrated sustainable outcome. Actors include the City of Freiburg, Forum Vauban (a community NGO), several co-housing groups, private developers and the local energy services company (MEFL, 2011). There are however three main acting bodies or institutions connected with Vauban[39]:

- *Project Group Vauban*, comprised of staff from the building department, the project group was the administrative coordination of the local authorities dealing with the Vauban project;

[39] http://www.vauban.de/info/abstract2.html

- *The Vauban Committee*, which was a committee of the City Council specially dealing with Vauban. These committee representatives from political parties discuss the main development issues together with representatives from the administration and further consultative members such as Forum Vauban. It was the main platform for information exchange, discussion and decision preparation (though decisions were made by the City Council). Additionally, there were regular meetings between members of administration and Forum Vauban. If necessary, further common initiatives such as round tables and workshops were organized. For the social work within the district further special committees were established, including more actors such as the city's welfare institutions. The cooperation is fixed by an agreement between the City of Freiburg and Forum Vauban;
- *Forum Vauban*, which is the local citizen's association and legal body of the extended participation process and the social work within the district.

After having purchased the site from the federal government, the city of Freiburg had organized a design competition in 1993 (Kasioumi, 2011). Planning practice in Germany requires the local land-use plan to contain legally binding designations for urban development and an environmental assessment (ibid). Based on the competition's winning design, a project-based land-use plan was prepared.

Shortly thereafter, the development process started around 1994 with a group of ecology-oriented people who discussed the recent acquisition of the Vauban property by the City of Freiburg. The possibilities of a residential district, built with environmentally friendly construction materials, energy concepts, largely car-free living and public participation in the planning process were discussed. A non-profit organisation, 'Forum Vauban', was founded and after two months the Forum had grown to 60 members who lobbied at the City Council with their ideas for a sustainable neighbourhood (Schroepfer & Hee, 2007).

The City of Freiburg decided that the Vauban area was to be converted into a flagship environmental and social project (Schroepfer & Hee, 2007). Reflecting the long-standing tradition of sustainable urban development in Freiburg, the document already contained a number of sustainable principles such as low-energy buildings, priority for non-car access, and mixed-use medium density design. The same model as applied in a nearby brown-field re-development project[40] on the western edge of the city with energy-efficient buildings, on-site services, jobs and a low-traffic design was to be applied to Vauban (ITDP, 2011). Despite the expressed desire to create a flagship environmental and social project by the City of Freiburg, the community NGO 'Forum Vauban' continued to lobby in an attempt to introduce more radical design measures into the master plan (ibid). The Forum received funding from a variety of sources, including the EU's LIFE Programme, the City of Freiburg, and from the German government, and was thus able to become a rooted citizen's body and influence the process (Scheurer & Newman, 2009). Changes to the plan emerged trough meetings of the Committee and Forum Vauban, causing the plan to be amended five times between 1999 and 2007 (Kasioumi, 2011).

By the year 1995, the City of Freiburg had formed a partnership with the Forum and named it the official legal body for an 'Expanded Public Participation' process, which was to be incorporated in the development of the districts' master plan. Under the public participation model, the City worked together with residents on the plan to ensure that community needs were represented in the development. Representatives from the City Council, the City Planning and Building Office had the responsibility to determine the regulations such as the low-energy construction standard, the traffic concept, water management, building heights, and the general development structure (Kasioumi, 2011). Moreover, the cities' marketing and financial concerns were also determined by the Council and Project Group. This provided Forum Vauban with a framework within which to operate. The Forum had the responsibility to bring future residents together with project partners such as architects and builders to begin shaping the development of Quartier Vauban. Assisting people to help translate their ideas of sustainable living into feasible plans, and guiding them through a council planning department was an invaluable role of the Forum and averted some inevitable conflict potential (ibid). When

[40] The redevelopment project of Rieselfeld.

the first new residents moved into the district, the responsibilities of Forum Vauban shifted to more practical work within the community. Interactive workshops were held to establish the final design of streets and green spaces. Through this process, a comprehensive vision and plan for the development of Vauban was created to support its development. The final plan was approved by the end of 1997 and Freiburg completed the sale of properties to private builders and cooperatives, so construction could begin in April 1998. When the project neared completion, the Forum disbanded and left the responsibility of neighbourhood advocacy to residents' associations (ibid).

Figure 16: Development process

A large component of the project plan was the development of Vauban through 40 co-building/co-housing groups (see text box) that were established by future residents. These self-governed, non-profit developers called '*Baugruppen*', were an important innovative feature as it enabled people of moderate income levels to develop new housing that suited their aspirations as discounts were available to groups of people that decided to build together (ibid). In the master plan, the City Council prescribed that a large number of the individual blocks in the development of Vauban were to be sold to small cooperatives of owner-occupiers, each comprising 3-21 households (Scheurer & Newman, 2009). To date, 30-40% of the housing stock in Vauban is built using this approach (Williams, 2012). These *baugruppen* share the responsibility for the detailed building design of their shared property, incorporating their specific needs and wishes in a common plan. The cooperative design process in the early stages of the project "not only resulted in a remarkable diversity of architectural and open space solutions", but also created a "robust and conflict-tested neighbourhood" (Scheurer & Newman 2009, p. 5). The unique position of future residents resulted in some 40 groups of *baugruppen* and the establishment of the self-organised S.U.S.I.-settlement[41] initiative and the GENOVA co-operative, providing even people with low income levels with the opportunity to participate in the project. Although similar models do exist in other major cities such as Munich and Berlin, Freiburg is seen as one of the pioneers for this approach to urban development (Williams, 2012).

When the Forum started its activities in 1995, several working groups attracted volunteers from the region and were facilitated by the Forum, committees of paid experts and external professionals. These working groups elaborated and refined Vauban's specific concepts on sustainability in building, mobility, energy and other areas. According to Scheurer & Newman (2009, p. 9) it was because of Forum Vauban and its "meticulous liaison work with prospective residents" that the necessary popular support for some of the district's most striking innovations – such as the parking-free and car-free principles, the emergence of owner cooperatives and the "instigation of building energy concepts far exceeding

Co-housing

"A concept gaining popularity in Germany and the United States, co-housing provides an opportunity for individuals to pool resources to develop medium density housing, rather than purchasing 'off-the-shelf' housing products. Bypassing a traditional developer allows the groups to build their needs into design, create a sense of community and, for some projects, achieve capital cost savings"
(MEFL, 2011, p. 22)

[41] Selbstorganisierte Unabhängige Siedlungsinitiative

the already stringent legal requirements" – was created.

Key to the Vauban master plan was the desire to make car use less attractive than other modes of transportation. However, the local authorities did not actively support the creation of a car-free residential district with parking-free streets. Planners were prevented from completely restricting parking altogether because every home is required to have access to a parking space under the Baden-Württemberg Land law (ITDP, 2011). Forum Vauban was able to negotiate a compromise resulting in the parking ration of less than 0.5 per housing unit, in which most of the parking space is located on the edge of the district. The compromise included a legal framework to satisfy the City of Freiburg. Residents of parking-free streets were to purchase a parking space in one of the parking garages near the edge of the district, initially costing 16.000 euro's plus a monthly service charge. If residents were to avoid this fee, a legal declaration had to be signed in which they would declare not to own a car (ibid).

Vision, goals & means

The vision of Vauban was to create a residential district with:

- Compact building, a district of short distances;
- Alternative energy and transport concepts;
    - Ecological-oriented energy use (local heating concept);
    - Low car strategies/concepts;
- High liveability;
    - Green spaces;
    - Family-friendly;
    - Social diversity;
- Prioritized allocation of land: private clients and cooperatives, self-help models over investors.

Overall, the vision about spatial development included an integrated approach to efficient land-use and alternative transportation measures in the urban development. In many ways Quartier Vauban was a test case in which the means to achieve innovative solutions for sustainable urban development were devised on the spot as scientific knowledge advanced (Kasioumi, 2011). Resultantly, the project results were very close to the theoretical project goals. Although the vision for QV did reflect a technology optimism, with a focus on solar technology, broad and visionary goals were broken down into measureable targets (ibid).

Earlier research has shown that Vauban featured ambitious objectives and that the planning process featured effective monitoring, feedback systems, good communication and sufficient resources available (Abdalla, 2012; Kasioumi, 2011). According to Kasioumi (2011, p. 103) the political support and alliance with Forum Vauban "was important for the most innovative of measures to be implemented."

In order to achieve the goals of the project, the local government provided to planning context for Forum Vauban to work with. The local government applied the concept of a 'managed market approach', which demonstrated a way "for government to leverage the benefits of private sector involvement in projects, while maintaining control over outcomes" (MEFL, 2011, p. 21). By doing so, the government created the context to achieve sustainability outcomes through community property development and a unique transport system (ibid). City engineers controlled building energy performance by instigating binding instruments such as development agreements to reach energy targets (Kasioumi, 2011). The focus on measurable targets has helped to achieve sustainable urbanism in QV.

In terms of resources, the bottom-up, low-carbon initiatives in Vauban have benefitted from an array of federal and local subsidy schemes (Williams, 2012). Low-cost capital loans[42] supported the energy refurbishment of existing stock and further construction of low-energy housing. Moreover, capital grants have been made available for the installation of renewable energy technologies. The 100,000 roofs solar

[42] For example the 'Kreditanstalt für Wiederaufbau banking group loans'

programme, provided by the German government from 1993 until 2003, offered low-interest loans for PV installations. The feed-in tariff system, supported by the 1990 Feed-in Tariff Law that was designed to level the playing field for renewables, has encouraged the investment in renewable energy projects in Vauban (ibid). At the local level, local funds have also been available from the energy company (Badenova) in Freiburg for local low-carbon energy projects (ibid). A key policy instrument is the widely known German feed-in tariff system that obliges electricity distributors to accept electricity from renewable sources at a higher price.

When the City of Freiburg bought the area from the Federal Authorities in 1992, the city was able to buy it for 54euro/m² instead of 425euro/m² in the surroundings (Energy-Cities, 2008). It is estimated that the global cost of developing QV is €500.000.000, representing only 3 to 5% more than a traditional construction site (ibid).

According to Forum Vauban (2004), the project had a special status as 'development site' and had its own budget ($85,000,000), which was controlled by the Project Group Vauban. The initial financing for the construction site clean-up and the development of the infrastructure have been supported by low-cost capital loans (6% of funds). As a whole, the project did not receive any further subsidies, although builders and co-building groups were able to receive support and tax reductions from the national government or the Federal State of Baden-Württemberg. The Forum received $200,000 from the above budget for the participation process and social work. Further financial support came from the German Environment Foundation (Deutsche Bundesstiftung Umwelt, DBU) (1996-2002: US $ 200,000), the European Union's LIFE-programme[43] (1997-1999: US $ 700,000) and other institutions. Together with membership fees and donations, the overall budget for the NGO (between 1995-2001) has been about $2,000,000.

Performance monitoring

According to Abdalla (2012), the Vauban development included a system of performance monitoring and feedback. Project management teams were responsible for the monitoring of performance and progress by the subcontractors and discrepancies were fed back to the Project Group Vauban.

Transformations

Adopted in 1986, the City of Freiburg based its future-oriented energy policy on three pillars; energy conservation, the use of renewable energy and new sustainable technologies. This approach has attracted many research organisations and industries of international stature to the area (Scheurer & Newman, 2009; Kasioumi, 2011). Important organisation or institutes are the Fraunhofer-Institut focusing on renewable energy, the International Solar Energy Society, ICLEI as an umbrella organization for sustainability policy in local communities, and the Öko-Institut, a non-profit environmental research institution (Scheurer & Newman, 2009). It is this mixture of environmentally oriented institutions which provided government-sponsored incentives and innovative projects such as Vauban with a higher value and a sound basis with qualified labour and knowledge (Kasioumi, 2011). The presence of this environmental innovation industry provided the construction of Vauban with many contractors and sub-contractors, who could mainly be chosen according to their quality, past experience and applicability to specific needs (Abdalla, 2012).

Participation & Communication

In Freiburg as a whole, the level of local participation in decision-making processes and the provision of services is 'unusually high' (Williams, 2012). The challenge to create a healthy and sustainable urban district was, from the outset, considered to be delivered through a participatory approach and ultimately "catalysed into an exceptionally rich and synergistic participatory planning process" (Scheurer & Newman, 2009, p. 8). An important element in this approach was the early outsourcing from government to the local community organisation, Forum Vauban, as an intermediary between planning authorities and future inhabitants (Scheurer

[43] Since 1992, LIFE is the EU's financial instrument supporting environmental and nature conservation projects throughout the EU, contributing to the implementation, updating and development of EU environmental policy and legislation by co-financing pilot or demonstration projects with European added value.

& Newman, 2009; Kasioumi, 2011). The Forum was the catalytic agency in the communication and coordination amongst city officials, developers, scientists, politicians and the public, as well as in alliance building. As previously discussed, the Forum had the responsibility of bringing stakeholders together and assist in the process of translating ideas and wishes into plans. The Forum published a bimonthly magazine, brochures and manuals, excursions and workshops for future residents, builders, financial institutes and architects; supported co-housing groups on legal, technical and financial aspects; and sought partnership with research centres, institutions (such as ICLEI, the EU LIFE-program and the German Environment Foundation) which helped to build confidence in the project's mission and helped disseminate results (Kasioumi, 2011).

Residents were thus effectively involved in the design, realization and use phases of the development of QV through the Forum of Vauban that was in charge of all resident's training and communication between the Project Group Vauban and the City Council Committee (Abdalla, 2012; Williams, 2012). The Vauban Committee served to expedite communication between Forum Vauban delegates, who would sit in to advise councillors in advance of any political decision concerning the district. Moreover, the concept of co-housing provided different social groups to participate in the planning process, taking the form of resident's meetings, workshops, a cooperative council and resident representatives in the management team (Schroepfer & Hee, 2007). Through this process, the city council has maintained a high level of community involvement through forum Vauban but still closely managed the sale and redevelopment of the land to ensure best practice environmental sustainability and social outcomes simultaneously (MEFL, 2011).

In terms of *communication*, Vauban shows a high degree of knowledge transfer. Abdalla (2012) reports that guided tours, combined with intensive media interest and the dissemination of lessons learned have increased the external knowledge transfer both national as well as internationally. Moreover, internal knowledge transfer was achieved as the City Council Vauban Committee was set up on site by the City of Freiburg, to function as the main platform for information exchange, discussion, decision preparation and training to all stakeholders (ibid). In this regard, Scheurer & Newman (2009) elaborate upon the essential role of working groups and external experts as discussed earlier. Bringing together the expertise from different sources has accumulated knowledge and resulted in a string of publications trough Forum Vauban, which strengthened the position of the community's aspirations in negotiations with the city. This combination of communication, knowledge transfer and participation has led to enhancing the prospect and diffusion of innovative ideas (ibid).

Environment

The case of Vauban has some specific factors that were external to the planning approach, which helped to expedite the development of a low-carbon neighbourhood. The project is symbolic to the stimulus of Germany's green movement, and the specific cultural context in Freiburg can be seen as integral to the success of the planning approach to developing Vauban (Williams, 2012). The city government is run by a coalition of conservatives and Green Party councillors, with the Greens holding most of the seats. During the European elections, the Green Party won 60% of the poll in Vauban (ibid). The green agenda of the City Council started soon after the energy crisis of the 1970s. The regional government had planned a nuclear power station some 40 kilometres from Freiburg in response to an expected shortage of oil. Campaigns against the power station began and, over time, gained wider political support from the city and region, subsequently becoming an example of sustainable development and a stronghold of green politics. As a critical side-effect, it has raised awareness of energy policy issues and marked the importance of participation in political processes (Scheurer & Newman, 2009). The unusually high degree of community involvement shows that the local authority is open to different viewpoints, is receptive to grass-roots influence over the project and displays the proactive nature of Freiburg's ecology-oriented residents. In this respect, research has shown that 60-70% of Vauban residents vote 'green'. This process led to the adoption of the future-oriented energy policy in 1986 which attracted many research organisations and sustainable industries to the area (Kasioumi, 2011).

Continuity

In the development of Vauban, there was no individual 'project champion', but rather a group of people who formed Forum Vauban, which proved to be essential for the sustainability outcomes of the project. The Forum acted as a change agent and provided trainings and workshops to promote the project's objectives and new lifestyles (Abdalla, 2012). Moreover, the City of Freiburg played an exceptional role in the provisioning of leadership by initiating a strong environmental program, political stability and providing the support where needed (ibid). Most notably, however, the 'extended public participation' in Vauban meant that different viewpoints were fully considered and resulted in an "exceptionally rich and synergistic participatory planning process", aiding the project's continuity (Scheurer & Newman, 2009, p. 8).

Continuity of the project was, moreover, supported by implementation of the co-housing concept. Because the financial risks and benefits of the project are shared by all members of the community, according to their financial stake in the project, the overall risk and uncertainty of the development is minimized (MEFL, 2011). Such a collective approach to urban development allows building to take place on a larger scale, and resulted in an estimated cost saving of up to 25% for Vauban, including 10% saving from reduced risk and holding costs that developers would normally incur (ibid). On the other hand, Abdalla (2012) reports that Vauban in part could not display continuity as the reported thermal discomfort complaints have not been solved yet.

3.4.2.2 GOVERNANCE ANALYSIS: ROLE OF THE GOVERNMENT

Characteristic for decentralised governance, the *initiating actors* for the development of Vauban lies with the City of Freiburg when the city bought the land from the federal government and started developing a project-based land-use plan. However, with the City Council's historically driven green motivation to support sustainable development, *the stakeholder position* in Vauban had considerable autonomy to deliver outcomes in support of the City's overarching ambitions, within predetermined boundaries such as the low-energy housing construction resolution. This is more characterised in a public-private governance approach or, to some extent, with the concept of co-housing, self-governance. The *policy level* for Vauban was at multiple levels, as local regulations were inspired by national ambitions and requirements. The City of Freiburg, however, is known internationally as one of the birth places of the green movement and its ambitious targets for CO_2 reduction (ICLEI, 2009). Specific policies for the local context were therefore devised and implemented at the local level. The formal *basis of power* of the key actors involved can be characterised as a mixture between authority embedded in rules & legislation on the part of the local government, and by authority embedded in legitimacy trough leadership and agreement on regulations and procedures. The City of Freiburg, as a self-governing entity, played an important role in the provisioning of leadership by initiating a strong environmental program, political stability and providing the support where needed. However, private actors and civil society too had considerable powers in shaping the new district with the creation of new forms of urban design procedures. This is exemplified by Williams (2012) who stated that the government's planning system has played an important role in the incorporation of low-carbon energy systems in Vauban as its role was largely regulatory and facilitative.

Regarding institutional features, the *model of representation* can be characterised as corporatist or as a partnership. The City of Freiburg has actively supported the 'extended public participation' in Vauban meant that different viewpoints were fully considered and resulted in an "exceptionally rich and synergistic participatory planning process" (Scheurer & Newman, 2009, p. 8). Private and civil society actors were first indirectly involved trough lobbying, soon after which the extended public participation and the naming of Forum Vauban as the official legal body for the participatory approach, enabled direct involvement in decision-making. This process allowed for the *rules of interaction* to be a mixture of formal and informal exchanges rules. Overall, the *mechanism of social interaction* can thus be characterised as a mixture of hierarchic and horizontal mechanisms. Hierarchic trough top-down implementation of standards and requirements and horizontal mechanisms trough extended participation and interactive processes characterised by deliberation and negotiation on the targets for development.

Concerning the policy content, the overall goal of developing Vauban was driven by the ambition of sustainable development. *Goals and targets* were either uniform for Freiburg City, or tailor-made especially for Vauban, again being a mixture of public-private governance and interactive governance. The predominant *policy instruments* to achieve these goals and targets are typical of public-private governance with the feed-in tariff and several grants (subsidies from the regional utility) being important incentive based instruments. Moreover, more centralised governance approaches are used in terms of legislation, norms and standards (i.e. the low-energy standard). In terms of *policy integration*, Vauban is an acknowledged example of a low-carbon urban development with an integrated policy approach, including ecological solutions for most relevant sectors (transport, energy, mixed-use structure etc.). Finally, regarding the *policy-science interface*, the development of Vauban is typical to the interactive governance approach in which transdisciplinary knowledge, coming from expert and lay knowledge, was used to integrate the different policy aims for the local context of Vauban.

Concluding, the governance approach taken in Vauban shows characteristics of decentralised governance, with a focus on public-private governance and interactive governance.

3.4.3 STIMULATING FACTORS

The above analysis of the planning process for Quartier Vauban presents certain underlying factors in the local context of Freiburg that facilitated the realization of these low-carbon development projects. Some factors relate to the planning process, whilst others are independent of the chosen approach.

Much of the success of Vauban seems to be defined by the city's ability to implement the ***'managed market approach'***, providing the boundaries, regulations and incentives to manage commercial interests while social and environmental outcomes were delivered by a range of stakeholders (MEFL, 2011). The managed market approach reinterprets the traditional roles of public and private players and has benefitted the development of Vauban. When the city of Freiburg was searching for a site to meet the demand for housing to accommodate the growing population, the city was able to buy the land from the federal government at reduced rates. As the land was now under ***'municipal ownership'***, development could take place without the potential conflicts arising from a situation with different private land-owners (Kasioumi, 2011). As the land-owner, Freiburg provided an ambitious vision for the development of Vauban, specifying the environmental regulations and providing incentives accordingly. Within this context, commercial and community interest were able to freely innovate to devise measures that supported the overall vision (MEFL, 2011).

Moreover, community participation at each stage of the development process was critical to the projects' success. The early involvement of Forum Vauban in a ***'public-community-partnership'*** is an important stimulating factor as it enabled the goals to be achieved with technical and social innovation (Scheurer & Newman, 2009). The fact that the City Council had a green agenda and was receptive to the idea of grass-roots influence over the project aided the advocacies of the Forum and opened the door for the development of a low-carbon urban district. The high level of community participation (local business and residents) in the process of planning QV, has helped to raise '***awareness***', engage public interest and involvement in the project (Williams, 2012). In addition, ***'the co-housing concept'*** applied in Vauban allowed for financial risks of development to be reduced as financial risks of construction projects, as well as the financial benefits, are shared amongst the members of the construction community (MEFL, 2011). Moreover, it resulted in higher sustainability outcomes and substantial cost-savings (ibid).

The ***'sympathetic political climate'*** for environmental measures and a continued presence of green parties in the city council has aided its development and created the context to achieve sustainability outcomes through community property development and a unique transport system. The improved environmental impacts in the development of Vauban has been made possible by a '***mix of stick and carrot measures'*** as city engineers controlled building energy performance by instigating binding instruments such as development agreements to reach energy targets or provided incentives for car-free households (Kasioumi, 2011). Moreover, the city of Freiburg showed ***'political leadership***' with the establishment of the energy standard that required buildings to be constructed to an energy standard that was well ahead of minimum requirements and

only six years later became the national standard (MEFL, 2011). Especially for Freiburg, where an aversion towards a planned nuclear power plant in the 1970s, has acted as a "***window of opportunity***" as it spurred community cohesion and activism which shaped political and community awareness in the past. Because of its long tradition of being a leader of green policy, new developments in Freiburg were inevitably influenced by sustainability principles. It was this combination of public subsidies and the local cultural context that gave the cooperative planning approach greater leverage (Williams, 2012).

The specific cultural context moreover minimized potential conflict about development priorities and provided the grounds for '***bottom-up pressure***' for innovative processes (Kasioumi, 2011). Despite the instigation of the ambitious energy standard by the city of Freiburg, energy efficient innovations in Vauban moved beyond the standard during the planning and implementation phase (Scheurer & Newman, 2009). It is the pressure and involvement from a group of middle class, well-educated people, motivated by a green agenda, which shaped Quartier Vauban and introduced the sustainable lifestyle that proved to be absolutely crucial for the success of Vauban (Abdalla, 2012; Williams, 2012; Scheurer & Newman, 2009). This group of people provided ***'community leadership'*** in the sense that it broadened the project, especially in relation to the low-car design. Major driving forces for the low-carbon development of Vauban have been the ideas, creativity and commitment of the people involved who shared a common goal, and it is the intent of the city to structure the planning process in a cooperative way which led to the successful implementation of the concept (Schroepfer & Hee, 2007).

The most significant factor in applying the Vauban model with its sustainability principles therefore was the use of the '***public-community-partnership'*** with Forum Vauban as it enabled the goals to be achieved with technical and social innovation (Scheurer & Newman, 2009). The fact that the City Council had a green agenda and was receptive to the idea of grass-roots influence over the project aided the advocacies of the Forum and opened the door for the development of a low-carbon urban district. The high level of community participation (local business and residents) in the process of planning QV, has helped to raise awareness, engage public interest and enabled residents to be proactive in the participation of the design (Williams, 2012; Kasioumi, 2011).

Moreover, the future-oriented energy policy of 1986, with its focus on CHP and the use of renewable energy sources, attracted many research organisations and solar industries to the area, providing government-sponsored incentives and innovative projects such as Vauban with a higher value and a sound basis with qualified labour and knowledge (Kasioumi, 2011). The ***'presence of an environmental innovation industry'*** and the ***'use of proven technology'*** stimulated the low-carbon development of Vauban as it minimized potential conflicts about investment in a particular environmental technology, and improved technical performance as it tapped into a technical area where they already held a strong position.

The combination of political leadership, community activism, the public-community-partnership with Forum Vauban and the use of 'baugruppen' as self-governed, non-profit developers, proved to be a powerful collaboration structure in the process of developing Quartier Vauban. The level of synergy that followed from this collaboration structure "eventuated in a multiplicity of experimental and daring solutions to planning tasks when Vauban was developed from early 1998 onwards, proving as inspirational to sustainable building" (Scheurer & Newman, 2009, p. 9).

3.4.4 CONCLUSION

Vauban was largely successful in reaching its ambitious targets. Especially its results in the field of energy and transportation are remarkable. Vauban reached an energy performance that is radically lower than the already progressive and ambitious energy standard which, years later, was to become the national standard. Most importantly however, Vauban reached a carbon neutral status in stationary energy. Moreover, the district is radically less car dependent than most districts built over the past 50 years. These results cumulate into a per capita carbon footprint that is radically lower when compared to Freiburg residents.

The Vauban project thus is an example of a successful low-carbon neighbourhood which reunites several approaches, that formed the basis for a facilitative context that nurtured and encouraged innovative ideas for low-carbon development. The analysis has shown that redevelopment of brownfield sites should be supported by the local community. The ***'participatory approach'*** has had a positive effect on a number of critical aspects for the development of a low-carbon urban neighbourhood. It helped raise awareness on energy, engage public interest and involvement in the development. Moreover, it has helped to build local social capital, which in turn created the support and social structure needed to encourage pro-environmental behaviour, carbon reductions and the development of collective approaches towards energy generation and conservation. However, as Williams (2012, p. 138) asserts "such an approach works well in localities where the public is already engaged, proactive and supportive of environmental objectives, but of course in many communities this is not the case." Vauban residents were very proactive and were keen to tackle energy consumption and their carbon footprint. For a context in which residents are largely unaware, disengaged and passive, "it seems unlikely that this planning approach would bring about the same results" (ibid: p. 138). Although such an approach is resource intensive and it might lengthen the process of development, Vauban shows that it has significant benefits and did not lead to a substantial increase in the overall costs.

Moreover, the case of Vauban shows the importance of political leadership in the development of low-carbon communities. The Freiburg planning approach, next to the facilitative role in which community participation was extensive, has elements of the regulatory and strategic role in the delivery of low-carbon neighbourhoods. The ***'managed market approach'*** as applied in Vauban, seems to be a fruitful approach to the more regulatory and strategic roles in steering urban development into the direction of sustainability. However, the case study shows that it requires political leadership in the sense that local governments, rather than relying solely on private initiative, should take the lead with innovative ideas, measures and spatial strategies. By doing so, government provides private and community actors with a stimulating and facilitative framework within which creative solutions and progressiveness for low-carbon urban development have the freedom to mature.

The co-housing model[44], featuring several '*baugruppen'*, is a concept that could be transferred to future low-carbon districts. The concept could assist in the creation of vibrant and liveable low-carbon communities and help counteract the identical and anonymous new built of contemporary urban development. Moreover, because of the green orientation of Vauban residents, the co-housing model resulted in higher sustainability outcomes. The prospect of such benefits and the related cost-savings might well be a stimulating factor for the development of future low-carbon districts.

The transport model of Vauban, being spatially and economically decoupled, could be transferred to other low-carbon developments, but will probably unlikely be accepted when the incentives as can be found in Vauban are poor or absent. Vauban shows that legal barriers can be overcome through participatory approaches such as the ***'public-private-partnership'*** with Forum Vauban. Although city planners were receptive to the idea of sustainability, the transport model of Vauban would not have been possible without the parallel working structures of the Forum, offering innovative solutions and a driving force when legal barriers obstructed progression in sustainability. To this day, however, the City of Freiburg does not support the

[44] Also known as 'collective commissioning' or in Dutch 'Collectief (Particulier) Opdrachtgeverschap (CPO).

parking-free streets concept, which exemplifies that such progressive initiatives are only likely to be considered "if grassroots campaigns to demand them are mounted by the electorate" (ITDP, 2011, p. 97).

It thus appears that the cooperative local planning forms the basis of the districts' success and could be transferred to other developments. Especially in the initial stages of the project it seems important to achieve a high level of motivation and support for low-carbon development amongst residents, politicians and actors in charge of implementation. This approach together with the concept of co-housing provides a model that could be used to deliver future low-carbon neighbourhoods. However, the approach is hugely depended on the cultural context. But the case of Quartier Vauban exemplifies that in small-scale developments where proactive citizens can be engaged, the bottom-up approach to planning in conjunction with public funding, could help facilitate the transition towards low-carbon urban development.

4 CONCLUSION & DISCUSSION

The question of how to get from the rhetoric of low-carbon urban redevelopment to the reality of such urban developments' is a neglected one (UN-Habitat, 2011). In this thesis I have traced some features of the development processes in four exemplary cases of 'low-carbon urban redevelopment'. Most of the projects arose during the mid-1990s and transformed brownfield sites into thriving low-carbon residential neighbourhoods. Some of the case studies were initiated out of a particular event, others were initiated through bottom-up pressure or private initiative. These studies proved to be important explorations towards depicting the stimulating factors for low-carbon urban redevelopment at the neighbourhood scale. The case studies exemplify that integrated planning will be critical in making the transition towards a more sustainable society.

What is the level of ambition of governments and, at the local level, the project ambition?

The case study analysis has shown that the ambition level for a low-carbon society, deviated between the different countries. The Netherlands, as the only country holding on to the formally agreed 20% reduction level by 2020, appears to have the lowest level of ambition in this context, much of which can be explained by the volatile political character (Agterbosch, et al., 2007). Changes in the Dutch political climate, greatly affect sustainable development policies and incentives. The Clean and Efficient program of 2007, for example, which had the ambition to reduce GHG-emissions with 30% in 2020 was abandoned in 2010 as a result of shifting political priorities (ECN, 2011). Such a volatile political climate impedes with the creation of a market environment which is suitable for sustainable innovation and entrepreneurship as it creates uncertainty in project developments.

Along with Germany, the UK is often mentioned as a 'climate champion' (UN-Habitat, 2011). However, climate champions struggle to comply with their carbon reduction targets as well. The UK remains slightly behind on the other countries in terms of reduction targets for 2020, and has missed its previous ambitious goal of a 20% reduction in CO_2 emissions by 2010 (Cambridge Econometrics, 2011). On current policies, the UK is not likely to meet the 20% reduction until 2020 (ibid).

Germany is often mentioned as a leader and example to other countries in relation to sustainable development and the reduction of CO_2 (UN-Habitat, 2011; European Commission, 2011). Through legislations such as the 'Renewable Energy Sources Act' and eco-taxes, renewable sources are promoted trough feed-in tariffs. The country succeeded in providing entrepreneurs and investors with enough confidence and support to create an impressive sustainable economy (ibid). With its 40% reduction target by the year 2020, Germany is on an equal ambition level with Sweden. The latter has been considered a forerunner in environmental policy and implementation as well (Khakee, et al., 2008). Although all governments were on track to meet their respective burden-sharing target by 2010, different achievements in emissions reductions can be seen in the period 2008-2010 (EEA, 2011). The Netherlands had achieved the lowest emission reduction, followed by Sweden and Germany. The United Kingdom had achieved most reductions by 2010 (Table 21). Moreover, all national governments have ratified the UNFCCC and the Kyoto Protocol and signed the Agenda 21. At the local level, it was found that all cities have signed the Covenant of Mayors, the Aalborg Charter, ICLEI and (apart from London and Amsterdam) the Aalborg Commitments.

The *project specific level of ambition* is difficult to evaluate because of the differences in size, time of development and focus on urban development. Table 21 provides an overview of important ambitions and achievements in the different case studies. However, it can be argued that the 50% reduction of overall environmental impact and the sheer size of Hammarby Sjöstad, the carbon neutral ambition of BedZED and the low-energy standard in Vauban can be seen as ambitious levels for development.

Table 21: National government ambitions

Country	Target	Year	Emission reduction over 2008-2010	On track to meet burden-sharing target by 2010?
Sweden	40% GHG-emission reduction	2020	13.2%	Yes
Netherlands	20% GHG-emission reduction	2020	3.9%	Yes
The United Kingdom	35% GHG-emission reduction	2022	24%	Yes
Germany	40% GHG-emission reduction	2020	22.6%	Yes

Table 22: Project specific ambition and achievements

Project	Ambition	Target	Achieved
Hammarby	Overall reduced environmental impact and half the amount of energy used in contemporary new urban areas dating from the early 1990s in Stockholm	50%	Reductions range between 23 and 70% for different sectors. Reduction related to buildings lie between 40-46%.
	The total requirement of supplied energy should not exceed	60 kWh/m^2	120 kWh/m^2/year
BedZED	Renewable energy use	100% / carbon neutral	56% / not carbon neutral
	Reduction of potable water use	50%	58%
	Reduction of electricity consumption	33%	45%
GWL-terrain	Car-free development	0.2 cars/apartment	0.25
	Reduced natural gas consumption for heating	750m^3	750m^3 (48% compared to the 1993 Dutch average)
Vauban	Low-energy standard	65 kWh/m^2/year	65 kWh/m^2/year and 92 passive house buildings (15 kWh/m^2/yr), carbon neutral in stationary energy

In conclusion, however, it is difficult to pinpoint a specific level of ambition which is conducive to low-carbon urban development. Nevertheless, the analysis has shown that the German and Swedish governments have been most ambitious in the ambition to reduce GHG-emissions by 2020. Interestingly, the cases found in these countries, were in this research also the case-studies with the highest ambitions and political climates most conducive to low-carbon urban redevelopment. Future research should focus on the effect of national government ambitions on lower levels of government and to what extent it permeates from higher levels of government to lower levels of government.

What results were achieved?

Regarding the *level of success*, Table 22 provides an overview of achieved results. The projects differ in their outcome but also in the opportunities for evaluation. As mentioned in previous chapters, the goals and targets formulated in Hammarby and the GWL-terrain were to a lesser extent quantifiable than they were ambitious. This impedes with the opportunities for monitoring and evaluation. Hammarby Sjöstad has achieved considerable results, but has not reached its overall limit of 50% reduction. BedZED's initial aim to be carbon

neutral was not achieved, but the development did achieve considerable results in water and energy reductions. The GWL-terrain has mainly been successful in the creation of a livable residential neighborhood for families with children, and the car-free concept. Implemented environmental measures, however, were soon outdated and their effect is debated. Lastly, the development of Vauban has been largely successful across the board, and most notably in its achieved results for energy reductions (carbon neutral status). Moreover, the district is radically less car dependent and has a high diffusion of solar energy technology. In conclusion, differences in project outcome can thus be observed. The question of which stimulating factors had been at the basis for project success remains to be answered.

What measures and instruments can be identified in low-carbon development approaches?

As mentioned in the introduction, there are roughly five fields of activity in spatial planning in which LCD strategies can be incorporated (Corfee-Morlot, et al., 2009). These *fields of* activity stipulate the activities in which LCD projects could aim to lower CO_2 emissions. Interestingly, all of the case studies showed approached to integrated urban planning. All fields of activity (energy, transport, waste & water and urban land-use & spatial structure) were to some extent addressed in the developments. As urban areas "consume the bulk of the world's energy and [are] thus perhaps the single largest 'source' of global CO_2 emissions" (Corfee-Morlot, et al., 2009, p. 17), it is not surprising that all projects had a particular focus on the issue of energy. Especially Vauban is an interesting example of sustainable energy in urban areas. However, other fields of activity were also addressed in the case studies. Vauban, GWL-terrain and Hammarby Sjöstad in particular, had a focus on sustainable measures in the field of transport. Water and waste management was particularly addressed in BedZED and Hammarby Sjösad and all projects paid particular attention to sustainable urban land-use & spatial structure. Although a focus on energy is obviously not a disadvantage, the other sustainability features should not be undermined or less prioritised. Local transportation options, for example, can greatly affect the carbon reduction potential of urban areas.

Most notably in the application of different technologies has been the development of Hammarby Sjöstad. Different technologies have been applied to reduce the overall environmental impact. Interestingly, all case studies have implemented a combined heat and power plant, with mixed results. The CHP-system at BedZED soon failed after implementation due to a variety of underlying reasons. Conversely, the CHP-systems at GWL-terrain, Vauban and Hammarby Sjöstad are still functioning. Other often used technologies or measures include photovoltaic panels, wastewater treatment plants (producing biogas), FX-ventilation systems, extra insulation, sustainable building materials, reuse and recycling of building materials, and passive solar energy.

Additionally, the case studies exemplify that, despite our increasing technical ingenuity, residents continue to play an important role in the outcomes of green development projects. Changes to the physical environment can only go so far in achieving carbon emission reductions, supporting changed lifestyles is crucial for the development of successful low-carbon initiatives (Abdalla, 2012; Williams, 2012).

How was the developing process organised and executed?

It is easily assumed that, upon project completion, the development process behind each case study has been the result of a culmination of smooth processes with clear ambitions, targets, political support and cooperative partners. The analysis has revealed differences and barriers in the developing process and its effect on successful outcomes. These four case studies have facilitated the analysis of background processes and influences on project success, providing more insight into the stimulating and limiting factors in low-carbon urban redevelopment initiatives. Different approaches to planning and its effect on project outcome have been identified. In conclusion, all of the case-studies have shown participatory approaches to planning, with the exception of the involvement of the community in Hammarby and BedZED where mainly public and private actors were involved. Differences in the planning process have revealed discrepancies in the ambitions and outcomes, which provided the stimulating factors for answering the main research question.

What is the applied mode of governance?

The importance of the Public Authority has been exemplified by the case study analysis. The initiating actor were local authorities in three of the analysed cases, except for BedZED. The case studies in Hammarby Sjöstad, Vauban and Amsterdam have primarily been initiated by their respective city or district councils, which were interested in implementing a demonstration project in collaboration with open-minded developers. Moreover, the public sector held ownership of the land and showed considerable support in the initiation phases of the projects, by either selling the land to lower prices (BedZED) or securing the land for development as is the case for the other cases.

Public engagement has primarily been addressed in Vauban and GWL, and has largely been absent in the development of HS and BedZED. The high degree of cooperation in Freiburg and Amsterdam, raised the level environmental performance and helped raise awareness on the effect of resident behaviour on project outcome. Less community involvement might reduce resident's education and public support for innovative projects. However, public engagement should be tailored to the specific context, depending on the complexity of the project and perceived effect of resident's behaviour.

In each of the four cases, the public sector took a multi-level approach, eventually settling upon a democratic participatory process. There is, however, a significant difference between 'participation' in HS and BedZED as compared to Vauban and the GWL-terrain. While the GWL-terrain and Vauban mainly focused on decentralised forms of governance with a characteristics of public-private partnership in an interactive process, Hammarby and BedZED had more centralised forms of cooperation in which the community was not involved. Participatory processes allow for different types of knowledge to be harnessed and increase support for innovative projects. Whilst communication and participation in Hammarby included broad exchange of information amongst city officials, developers and politicians, Vauban and GWL-terrain included lay knowledge as well.

Main research question: *"Which stimulating factors can be identified at the neighbourhood level, that might explain the success of low-carbon urban redevelopment strategies in front-running European areas, and could improve future initiatives of low-carbon urban redevelopment?"*

The research has shown that different stimulating factors determine the successful implementation and outcome of low-carbon urban development strategies at the neighbourhood level in different phases of the project. Without the aim of becoming overly prescriptive or complete about what approach planning should take, a first overview of stimulating factors or ingredients for future projects is offered below.

Although it is easier to build in a contemporary way, there is a need to re-think the way in which we build and re-develop our urban areas (Williams, 2012). This will challenges our abilities, and will increase the time and effort needed to develop along the principles of low-carbon development (ibid).

<u>In the initiation phase</u> of low-carbon development projects different factors seem to be of significance and provide 'the spark' for development. It appears that urban development with a significant low-carbon component requires significant '**leadership**' from certain actors who have '***the determination***' and desire to create something new and challenging, and for such a process to succeed. Leadership from political (Hammarby Sjöstad), private (BedZED), public (Vauban & GWL-terrain) or community actors (GWL-terrain & Vauban), who actively lobby for the low-carbon component to take root in contemporary urban planning is crucial to the first initiation of low-carbon development.

However, such initial leadership from individuals is often not sufficient for sustained action because of the temporary nature of their role within an organisation or because of the barriers that may be encountered (UN-Habitat, 2011). The presence and use of '***windows of opportunity***' helps for such initiatives to be strengthened by external factors, and creates opportunities for initiatives to remain at the forefront. Specific events or a culmination of factors can stand at the front-line of low-carbon development. In particular referring to Hammarby Sjöstad, the possibility of hosting the Olympic Games, and the requirements of the Olympic

Committee, provided determined politicians with the stimulus for actively lobbying for sustainable urban development. Future development should look forward to, and utilize, such critical moments that create the extra incentive needed to realize certain ambitions or initiatives. Moreover, a '***sympathetic political climate***', which supports such sustainable initiatives, will stimulate challenging ideas to take root. The case studies show that, it often requires '***political leadership***' in the sense that local governments, rather than relying solely on private initiative, should take the lead by creating a context in which sustainable urban development can thrive. However, local authority involvement has its limitations as authorities often do not have sufficient funding available, might not have the entrepreneurial experience or knowledge needed or capacity to develop the new area.

In the planning phase, the analysis has shown the importance of the adoption of an '***early and active cooperative approach to planning***'. Cooperation and partnership working can, to some extent, be seen in all of the analysed case studies. Cooperation between a variety of stakeholders creates opportunities of success through the *creation of trust*, *awareness* and increases the *knowledge-base*. The case study of Vauban, for example, showed that the 'public-private-partnership' with Forum Vauban enabled the further progress of the development. Although local authorities were receptive to the idea of sustainability, Forum Vauban offered innovative solutions and was a driving force when legal barriers obstructed the continuity of the project. Cooperative local planning forms the basis of project success and should be transferred to the development of future low-carbon projects.

Moreover, an '***holistic and integrated approach***' to planning seems to stand at the basis of a successful project. An holistic approach would not focus on just one potential area for mitigation efforts, but would recognise that different sectors of city life generate carbon emissions and require action. Low-carbon development was approached holistically in most of the case studies, incorporating a multitude of measures in different fields of activity (energy, transport, waste & waste, urban land-use & spatial structure). By doing so, the opportunities of reducing GHG-emissions are increased (UN-Habitat, 2011). Moreover, by approaching LCD holistically, project goals are more likely to be connected to local policy aims, raising the changes of '***local authority support***' for implementation.

Leadership remains an important aspect during the planning phase of low-carbon urban initiatives, especially when barriers to development are encountered. In all of the described case studies, a certain '***locally known and trustworthy organisation***' was present that provided leadership and enabled cooperation by acting as a mediator. In most of the cases this was the local authority, but in some cases a local NGO (either present beforehand or especially formed for the project) or the community itself was at the centre of the development. The importance of such an organisation is that it works as a sustained catalyst for change, working in a facilitative way and mediating between different parties. In HS for example, this organisation was primarily the City of Stockholm and in Vauban it was the organised group of residents who formed Forum Vauban. Next to these central organisations, the analysis has shown the importance of individuals in the developing process. Often referred to as '***project champions***', these individuals tend to provide the driving force, creativity, and dynamism for continued project development. In some cases project champions were the same individuals who provided leadership in the initiation phase and lobbied for the low-carbon component to be implemented (i.e. BedZED, GWL-terrain). Sometimes individuals within organisations, either the local government, NGO's, or private actors create this drive. Such dynamic individuals or groups often have a sense of urgency, sense of direction, and willingness to take risks. Moreover, project champions often have prior experience or knowledge on development issues. Such leadership provided by project a champion often works as a catalyst for innovative change.

The case study analysis further showed the importance of creating a comprehensive '***environmental plan***' with a '***clear ambition***' for the development. Although an ambitious vision does drive innovative development, but the ambition should not be unreachable. Additionally, '***clear and quantifiable targets***' should accompany the ambition. A clear ambition with quantifiable targets functions as a positive driving force behind development and enables '***continued monitoring of results***' during later stages of the project. Ambitions, goals and targets should as much as possible be '***identified at the very early stages***' of the project

and in '***cooperation with key stakeholders***', bringing-in *external knowledge* to define quantifiable and achievable targets which correspondent to *the needs of future users*. By doing so, planners make sure that environmental considerations are fully integrated into the urban planning and design. Moreover, in situations of distrust, as exemplified in the case of GWL-terrain, '***increased community participation***' can help to overcome barriers such as resistance to change, distrust and risk-perceptions.

However, despite the apparent need for partnership and cooperative planning, '***the importance of the Public Authority***', or local government, must not be underestimated. Although there are examples of radically decreased local government involvement, the local authorities remained important for the development. Local authorities in HS, Vauban and GWL-terrain have actively led the development, in some cases providing some or full funding, and in other cases have had a minor role in the initiating phase of the development by supporting the project with giving precedence for sustainable motivations over financial motivations. In Vauban the local authorities exerted a considerable stimulating force with the '***managed market approach***'.

During the planning phase, the results of the case study show that '***the use of proven/familiar technologies***' is an important stimulating factor for successful projects. When developers are able to benefit from the '***presence of an environmentally innovative industry***' during the planning phase of projects, and tap into a set of proven/familiar technologies to support the low-carbon development component, perceived risk for investors is reduced and the performance in the use-phase is likely to be raised. Depending on the nature and aim of the project, a decision on the level of experimental technologies should therefore be made.

In relation to the funding of low-carbon development projects, much of the analysed projects have relied to some extent on subsidies. However, as exemplified by the Dutch situation, depending on subsidies might increase the perception of risk and create uncertainty in project development. Projects should therefore, as much as possible, rely on a '***sound business model***'. An example could be a business model in which the initial higher costs for green development are returned to the residents' trough considerable energy savings.

<u>In the development phase</u>, '***continued monitoring***' of performance and compliance with the requirements is an essential stimulating factor for success. As much of the low-carbon reduction potential is incorporated in the physical built environment, monitoring should be aimed at checking whether building is done along the lines of the plans and requirements, in order to prevent construction errors. Quality was increased in projects where the responsibility for on-site control by a supervisor was clearly defined. In BedZED, the chief architect behind the concept provided day-to-day advice and monitored compliance on-site. Hammarby Sjöstad is an example where the responsibility for monitoring was not clearly defined and construction errors resulted in performance problems in the use phase.

'**Regulatory pressure'** and binding agreements with contractors and developers prove to be crucial in the developing phase of low-carbon urban development. When contractors are faced with the challenges of changing the contemporary way of building, operational goals should be enforced to prevent discrepancies between the goals and implementation from happening. Because of the decreased political interest in HS, the environmental program ended up with a less authoritative character, making it difficult to enforce operational goals.

<u>In the use phase</u>, when the initial low-carbon component has found its way to urban development and the development has been completed, project success is determined by a different set of factors. As suggested by Abdalla (2012) and Williams (2012), '***residents' behaviour***' is one of the factors determining the outcomes of sustainable projects. As can be found in Hammarby Sjöstad, physical measures in the built environment can only go so far in the reduction of carbon emissions. Sometimes, physical measures can entirely be contradicted if the behaviour is atypical to the desired or expected behaviour. When residents do not know, or will not use sustainable technologies as they are supposed to, physical measure will not contribute to project success. The analyses of BedZED and Vauban show that a '***focus on learning how to live a low-carbon lifestyle***' should go hand in hand with the physical planning of the residential area. A '***cooperative approach to planning***', in which the local community is involved in the planning and design phases of the project, could support the '*sustainable lifestyle*' predicament. By incorporating future residents into the design of a low-carbon neighbourhood,

awareness on issues such as energy consumption is raised. Residents should be informed upon entering the area about the sustainability requirements. The establishment of an '***environmental communication centre***', such as the GlashusEtt or a local environmental manager where residents can go to with questions and problems, supports the delivery of successful outcomes.

In conclusion, cities around the globe will increasingly and recurrently be challenged by climate change, the demand for carbon emission reductions, and the need for ambitious, holistic and integrated solutions for low-carbon urban development. The research, however, has shown that there is no ready-made approach to the delivery of low-carbon residential areas, or to the delivery of low-carbon solutions at the local scale. The case study analysis has shown that successful project development often depends on a mixture of stimulating factors. The above overview provides a list of 'ingredients' on which future low-carbon developments could build. However, because climate change will have different effects at different localities, low-carbon development should aim to integrate local policy aims and development issues. Moreover, the research has shown that low-carbon urban development should be best implemented through an *inclusive, cooperative and integrated approach* to planning and will benefit from *ambitious, visionary and proactive stakeholders* who are at the basis of the stimulus for the low-carbon component in contemporary urban development.

5 RECOMMENDATIONS & REFLECTION ON RESEARCH METHODOLOGY

The case studies in chapter 3 have largely been successful because of a focus on broad citizen participation and consultation procedures. The involvement of future inhabitants seemed to improve the performance in the use phase of the projects as it created public interest and residents were generally more aware of energy issues and had a sense of ownership in the project which increases the desire to succeed in project ambitions. Enabling future residents in the development process thus might build the necessary awareness and long-term support for sustainability measures in future low-carbon urban development. Residents who could not be involved the process, or future residents moving in to the area, can be informed trough environmental innovation centres in the neighbourhood.

Some lessons learned and recommendations for local planners and policy-makers are provided below:

- The opportunities for future low-carbon initiatives lie in the ability of governments to provide sufficient support and funding. Funding should fill the gap where the private sector fails or cannot raise sufficient funding for project development. This includes the creation of a stable policy arena in which the private sector is supported and challenged to develop new measures for low-carbon development. Exemplary in the creation of such a policy arena was the local government of Freiburg;
- Thus, the role of the public sphere, being local and national governments, should not be underestimated. Government have a clarifying role in the future direction of, i.e. energy production or transportation, policy to provide the private sector with the confidence to invest in low-carbon development;
- A cooperative approach to planning, in which the public sector benefits from working with the private sector and civil society, with a leadership role from the government in facilitating low-carbon growth, may be essential to increase climate resilience and mitigate CO_2 emissions in urban areas;
- The cooperative approach helps to introduce new and innovative ideas to planning or policy solutions, enhancing transparency and thrust in the process. Moreover, a public-private partnership approach can help overcome legal barriers to LCD;

Future research

The identified role of local and national government leadership for low-carbon development opens-up areas for future research. As the leadership and facilitative role of the government is likely to require increased regulation, incentives or taxes, the burden in governments is likely to increase. Future research could focus on the role of international regulation and its effect on low-carbon urban development at national levels. In the absence of internationally coordinated regulation, countries could minimise their imposed regulatory burden when competing on the international market. In other words, to what extent does international regulation have an effect on national governments' support for low-carbon development.

Reflection on the research methodology

The qualitative approach was the dominant research methodology in this research. The qualitative nature of the research allowed for a more dialogue-based method of collecting data through expert interviews. Despite the scale of the research, with four case studies, being relatively small, the type of approach allows for a more comprehensive insight into the stimulating factors for low-carbon urban development at the neighborhood level. Moreover, aligned with the explorative nature of this research and the relative infancy of low-carbon urban development, the qualitative case study approach has been identified as a suitable approach for research (Gerring, 2004).

Although the qualitative approach allowed for data to be collected in the form of the experts' experience and reflection, which provided more detailed and deeper understanding of the underlying mechanisms, some form of quantitative analysis could have been used in the analysis of the case studies. Transcribing the interviews, selecting keywords and grouping them into groups of stimulating factors might have supplemented the research outcomes. However, the research interviews were supplemented with

scientific literatures on the different case-studies to cross-reference the interviewees' statements and input which served to validate and strengthen the findings.

The analytical model used in this research was constructed from different scientific literatures. This approach served the research well, in the sense that it provided the analysis of case-studies with a guiding framework to identify discrepancies between case studies. The framework for the analysis of modes of governance proved to be useful to recognize perspectives on sustainable development. Although predominant modes of governance could be identified in some of the cases, most case studies had hybrid forms of governance. The model also brought forward the necessity for clear goals and visions to be defined for successful governance action at the local level.

In retrospect, the amount of data collected in the form of literature and interviews, was extensive. During the analysis phase of the research it proved hard to compare cases with each other and shift trough the amount of qualitative data collected. Moreover, data collection through interviews is time-consuming. The intensive and time consuming nature of data collection in qualitative research, necessitates the use of small samples. The analysis of four cases, within the time-frame provided, proved to be challenging but feasible. Problems were also encountered in finding an appropriate sample of interviewees for the case studies. The initial aim was to include Île de Nantes (France) in the case study analysis. It proved to be very difficult to find a representative selection of interviewees for the analysis. Likewise, difficulties were encountered in finding the actors involved as some of the projects were completed over 10 years ago. Most actors involved moved on to other organizations, other departments or had retired altogether. This required significant energy in tracking references and contacts. Moreover, because of the time between project development and the research, some interviewees had to think about the exact process. Interestingly, however, most case studies proved to be highlights in the careers of interviewees, helping them to remember the process of developing them.

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APPENDICES

A: OVERVIEW OF INTERVIEWEES

Case study	Name	Organisation/Position	Location of the interview
General	Interview A	Urban Designer	Amsterdam
GWL-Terrein	Interview B	Project manager at a housing corporation	Amsterdam
	Interview C	Westerpark Council	Amsterdam
	Interview D	Chairwomen of the 'Koepelvereniging'	Amsterdam
	Interview E	District director	Zaandam
	Interview F	Residents and working at AgentschapNL	Amsterdam
	Interview G	City Councillor	Amsterdam
Hammarby Sjöstad	Interview H	TU-Delft: Technology Dynamics & Sustainable Development (previous research experience on Hammarby Sjöstad)	Delft
	Interview I	City Planning Department	Hammarby Sjöstad, Sweden
	Interview J	Head of Communications in GlashusEtt	Hammarby Sjöstad, Sweden
	Interview K	Environmental Program Director	Hammarby Sjöstad, Sweden
	Interview L	Business Development Manager of the Stockholm Business Region Development	Telephone call
	Interview M	The City of Stockholm project manager for HS	Stockholm, Sweden
	Interview N	Architect at Tengbom and Project Developer of HS	Stockholm, Sweden
Vauban	Interview O	Independent renewables and environmental professional consultant at 'MadiSUN'	E-mail & Telephone calls
	Interview P	Passivhaus Architect living in Vauban	E-mail
BedZED	Interview Q	BedZED architect (ZEDfactory)	Hackbridge, London
	Interview R	Peabody housing association	London
	Interview S	Peabody housing association	London

B: INTERVIEW QUESTIONS

General

1. Please introduce yourself briefly;
    a. How did you get involved in the project?
    b. What was your function?
    c. During which period of time were you involved in the project?
2. What factors, according to you, have led to successful implementation of the project?
3. Why do you think this project is seen as successful?
4. Why and how did the initiative begin?

Political-Administrative

5. How would you describe the contact with the local government? Were they sympathetic / supportive?
6. What concrete support in the form of resources did they provide?
7. How did national & local policies affect the project?
8. Political leadership?
9. Political stability > certainty?
10. How did the city planning affect the implementation of the project?

Finance & Economics

11. How was the project funded?
12. What resources did you use to help with the process or with implementation and where did they come from? E.g. financial, material goods, labor, skills & knowledge, networks, community, natural?

Organizational structure & process

13. What was the largest obstacle in implementing the low-carbon design?
14. Was there a common, guiding vision developed and how did it influence the project?
15. Were specific goals formulated that would help realize the vision & how were they formulated? How did they affect the project?
16. Did you change the vision or ambition as you went along? How did this happen?
17. Were the stated ambitions realistic?
18. What stages did the process go through?
19. Within each stage, what were the objectives, what were the main activities, what were the main products, who were the main participants, what did you achieve?
20. Within each stage, did it go as planned? If not why? Can you identify specific problems and what you did about them? Can you identify anything that was especially important in achieving your objectives?
21. Who was responsible for pursuing goals? How much flexibility did they have?
22. How were decisions made?
23. How did future residents influence the project?
24. How important was individual leadership or management in the project?
25. Continuity of stakeholders of importance?
26. Presence of strategic alliances and/or networks?
27. What about stakeholder interests and the merging of those into one goal?
28. Sense of thrust?
29. Entrepreneurship?
30. Monitoring?
31. Were there clear responsibilities?

32. Willingness to take risks for the sake of continuity?

Knowledge & Participation

33. Where did the knowledge/information for the environmental design come from? Who decided?
34. What assessment tools for the environmental design were used?
35. Knowledge diffusion?
36. Was there a core group of participants?
37. How were core group members selected and why?
38. What was the level of a) awareness, b) interest / support, c) participation, in the transition across the community?
39. Did you run pilots of ideas? Did you deliberately try things out to find out more?
40. Which individuals were especially important? What role did they play, why was it so important?

Technical

41. Were there any specific initial conditions that you feel enabled the implementation of low-carbon technologies?
42. What technologies used in the project have been important in the success of the project?

Concluding

43. What advice would you give planners today who would be interested in developing low-carbon residential areas?
44. Would you do another project like this? What would you do differently?
45. > Would you mind rating these factors according to their importance in the project?